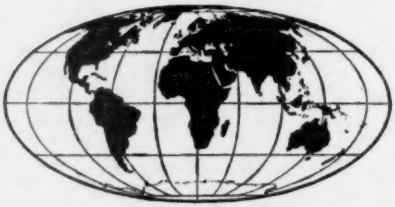
HALF A CENTURY OF PROGRESS IN ORTHOPAEDIC SURGERY

BRITISH VOLUME
Vol. 32-B, No. 4

NOVEMBER 1950

The Journal of Bone and Joint Surgery



1900-1950

Published at
LUDGATE HOUSE, FLEET STREET, LONDON, ENGLAND
(February, May, August, and November numbers)

8, THE FENWAY, BOSTON, MASSACHUSETTS, U.S.A.
(January, April, July, and October numbers)

The Journal of Bone and Joint Surgery

Copyright in Britain and the Commonwealth
Copyrighted by *The American Orthopaedic Association, Inc.*

The Journal is published in eight annual numbers—one every six weeks. The four American numbers are issued on January 1, April 1, July 1, and October 1; and the four British numbers are issued on February 16, May 16, August 16, and November 16. **The subscription price,** payable in advance, for the four British numbers alone, or for the four American numbers alone, is £2, 10s. (10 dollars). The combined subscription price for both British and American volumes is £4, 10s. (18 dollars).

The Journal is owned, and is published in the United States of America, by the American Orthopaedic Association. American Editorial Offices: 8 The Fenway, Boston, Massachusetts, U.S.A. Assistant Editor to the American Board: Miss Florence L. Daland.

The Journal is published in the United Kingdom by Messrs E. & S. Livingstone Ltd., 16–17 Teviot Place, Edinburgh. British Editorial Offices: Ludgate House, Fleet Street, London (Tel. City 5838). Editorial Secretary to the British Board: Miss Jean Barnes, Editor's Office, 82 Portland Place, London (Tel. Langham 1378).

THE JOURNAL

OF

BONE AND JOINT SURGERY

BRITISH VOLUME

Vol. 32-B

November 1950

PUBLISHED AT LUDGATE HOUSE, FLEET STREET, LONDON, ENGLAND

AMERICAN VOLUME PUBLISHED AT 8 THE FENWAY, BOSTON, MASS.

THE JOURNAL
OF
BONE AND JOINT SURGERY

REPRESENTING THE
SCIENCE AND PRACTICE OF ORTHOPAEDIC SURGERY

OFFICIAL PUBLICATION OF THE
British Orthopaedic Association
Australian Orthopaedic Association
Canadian Orthopaedic Association
New Zealand Orthopaedic Association
American Orthopaedic Association
American Academy of Orthopaedic Surgeons
American Society for Surgery of the Hand

Editor-in-Chief
WILLIAM A. ROGERS

British Editor
Sir REGINALD WATSON-JONES

American Editor
WILLIAM A. ROGERS

EDITORIAL BOARDS

Chairman
British Editorial Board
Professor GEORGE PERKINS

British Editorial Board

H. JACKSON BURROWS, *Deputy Editor*
J. CRAWFORD ADAMS, *Assistant Editor*
PHILIP WILES, London, *Treasurer*
ROLAND BARNES, Glasgow, Scotland
NORMAN CAPENER, Exeter, England
J. M. EDELSTEIN, Johannesburg, S. Africa
ALEXANDER GILLIES, Wellington, N.Z.
D. LL. GRIFFITHS, Manchester, England
ROBERT I. HARRIS, Toronto, Canada
W. L. MACDONALD, Sydney, Australia
B. L. MCFARLAND, Liverpool, England
A. V. MEEHAN, Brisbane, Australia
E. A. NICOLL, Mansfield, England
K. I. NISSEN, London, England
H. OSMOND-CLARKE, London, England
EDOUARD SAMSON, Montreal, Canada
H. L.-C. WOOD, London, England

Chairman
Editorial Committee, A.O.A.
FRANK D. DICKSON, Kansas City

American Board of Associate Editors

RUFUS H. ALLDREDGE, N. Orleans
JOSEPH S. BARR, Boston, Mass.
HARRY C. BLAIR, Portland, Ore.
WALTER P. BLOUNT, Milwaukee
FREMONT A. CHANDLER, Chicago
MATHER CLEVELAND, New York
JOSEPH A. FREIBERG, Cincinnati
G. E. HAGGART, Boston, Mass.
VERNE T. INMAN, San Francisco
J. VERNON LUCK, Los Angeles
H. RELTON MCCARROLL, St Louis
MICHAEL L. MASON, Chicago
LEO MAYER, New York, N.Y.
FRANK R. OBER, Boston, Mass.
WINTHROP M. PHELPS, Baltimore
R. B. RANEY, Durham, N.C.
A. R. SHANDS, Jr., Wilmington

Sub Editor to British Editorial Board: P. G. STUDHOLME, B.A., Ludgate House, Fleet Street, London, E.C. 4

Members of British Editorial Board retired in rotation:
1948—Sir HARRY PLATT, Manchester; F. W. HOLDSWORTH, Sheffield
1949—H. J. SEDDON, London; R. I. STIRLING, Edinburgh; G. T. DU TOIT, Johannesburg, S. Africa

EDITORIAL COMMITTEES

British Orthopaedic Association

SIDNEY L. HIGGS, *President*
J. CRAWFORD ADAMS, *Editorial Sec.*
PHILIP WILES, *Secretary*,
45 Lincoln's Inn Fields, London, W.C. 2

American Orthopaedic Association

FRANK D. DICKSON, *Treasurer*
FREMONT A. CHANDLER, *President Elect*
C. LESLIE MITCHELL, *Secretary*,
Henry Ford Hospital, Detroit, Michigan

Canadian Orthopaedic Association

J. EDOUARD SAMSON, Montreal
ROBERT I. HARRIS, Toronto
ALEXANDER GIBSON, Winnipeg
J. A. LEO WALKER, *Secretary*,
1538 Sherbrooke Street W., Montreal, Canada

American Academy of Orthopaedic Surgeons

JOSEPH S. BARR, *President Elect*
H. RELTON MCCARROLL, *Treasurer*
WILLIAM A. ROGERS, *Editor*
HAROLD B. BOYD, *Secretary*,
839 Madison Avenue, Memphis, 3, Tennessee

Australian Orthopaedic Association

ESMOND F. WEST, Adelaide, *President*
JOHN R. S. LAHZ, Brisbane, Queensland
ALEXANDER JUETT, Perth, W. Australia
ALEXANDER R. HAMILTON, *Secretary*,
135 Macquarie Street, Sydney, New South Wales

American Society for Surgery of the Hand

CONDICT W. CUTLER, Jr., *President*
MICHAEL L. MASON, *President Elect*
JOSEPH H. BOYES, *Secretary Treasurer*,
1401 South Hope Street, Los Angeles 15, California

New Zealand Orthopaedic Association

ALEXANDER GILLIES, Wellington, *President*
J. KENNEDY ELLIOTT, Wellington, *Secretary*
J. LESLIE WILL, Christchurch
H. WALDEN FITZGERALD, Dunedin
SELWYN MORRIS, Auckland, *Editorial Sec.*
3 Alfred Street, Auckland, C. 1, New Zealand

Orthopaedic Surgeons' Group of South Africa

J. M. EDELSTEIN, Johannesburg
G. T. DU TOIT, Johannesburg
J. G. DU TOIT, Pretoria
ARTHUR HELFET, *Secretary*,
808 Grand Parade Centre, Castle Street, Cape Town, South Africa

SUGGESTIONS TO CONTRIBUTORS

The Journal of Bone and Joint Surgery is the official publication of orthopaedic surgeons of the Commonwealth of British Nations and the United States of America, and in this respect it represents the science and practice of orthopaedic surgery in the English-speaking world; but important orthopaedic contributions are also reported from every country in the world, and original articles will be welcomed from any contributor, wherever he may live. Facilities for translation will be made available.

We are also anxious to report the Proceedings of Colleges, Universities, Societies and Associations in every part of the world in so far as they contribute to the advance of orthopaedic surgery. A measure of international co-operation in publication has already been achieved and this will be fostered and, we hope, increased.

Manuscripts offered for publication in the British volume should be addressed to the Editor, Journal of Bone and Joint Surgery, Ludgate House, Fleet Street, London. The Editorial Secretary of the Board is at the service of authors, and will assist in any way she can. Manuscripts offered for publication in the American volume should be addressed to the Editor, Journal of Bone and Joint Surgery, 8 The Fenway, Boston 15, Massachusetts.

Manuscript should be typewritten with double spacing and wide margins. The author should keep a carbon copy. The Editorial Board reserves the right to make literary corrections. Radiographs should be submitted as reduced or contact prints, but accompanied whenever possible by the original X-ray films which will be returned in due course. The Editor is anxious to emphasize this point. The quality of reproduction can often be greatly improved if authors will be good enough to submit X-ray films as well as reduced prints. Photographs, drawings, radiographic prints and films, should be numbered and clearly marked with the name of the author. Legends should be furnished in separate lists and not put on the back of the originals. Each figure should be referred to in the text.

References to medical literature should be recorded in the text with the name of the author and the year of publication in brackets. At the end of the article the list of references should be arranged alphabetically, each item including name of author, year of publication, title of article, Journal, number of volume, and page reference, thus:

GALLIE, W. E. (1948): Recurrent Dislocation of the Shoulder. Journal of Bone and Joint Surgery, **30-B**, 6.

The names of Journals should be given in full; the "World List" of abbreviations is not used. Every bibliography and list of references will be checked by the Editor, but much delay will be avoided if authors would be good enough to pay careful attention to accuracy.

CONTENTS

November 1950

Editorials Page

The Twentieth Century 451
The Background of a Half-century of Progress . . . *William A. Rogers* 451
The Dawn of Surgery . . . . . *Reginald Watson-Jones* 458
The Editorial of A.D. 2000 . . . . . *Bryan McFarland* 459

Historical Reviews

Orthopaedic Surgery in the United States of America . . *Leo Mayer, New York* 461
Orthopaedics in Continental Europe, 1900–1950 . . *Harry Platt, Manchester* 570
Fifty Years of Orthopaedic Surgery in Canada . . . *R. I. Harris, Toronto; T. B. Acker, Halifax, Nova Scotia; W. E. Gallie, Toronto; A. Gibson, Winnipeg; A. McLachlin, London, Ontario; F. H. H. Mewburn, Edmonton; J. A. Nutter, Montreal; J. P. Patterson, Vancouver* 587
Australian Orthopaedics in the last Fifty Years . . *H. Jackson Burrows, London* 601
The First Half-century of Orthopaedic Surgery in New Zealand *Coates Milsom, Auckland* 611
The Development of Orthopaedic Surgery in South Africa during the Past Half-century *J. M. Edelstein, Johannesburg* 615
Orthopaedic Surgery in Southern Rhodesia . . *J. H. G. Robertson, Bulawayo* 618
Half a Century of Orthopaedic Progress in Great Britain . *H. Osmond-Clarke, London* 620
Some Classics of British Orthopaedic Literature . . . *D. Ll. Griffiths, Manchester* 676

Clinical Studies

Medullary Nailing of Fractures after Fifty Years . *Reginald Watson-Jones, London; J. Crawford Adams, London; J. G. Bonnin, London; H. Jackson Burrows, London; Thomas King, Melbourne; E. A. Nicoll, Mansfield; Ivar Palmer, Stockholm; Frederick vom Saal, New York; Hugh Smith, Memphis, Tennessee; David Trevor, London; O. J. Vaughan-Jackson, London; A. D. Le Vay, London* . . . 694
Endocrinology and Orthopaedics in Fifty Years . . *S. Leonard Simpson, London* 730

Proceedings and Reports of Universities, Colleges, Councils and Associations

Great Britain, Canada, Australia and New Zealand, International Societies . . 741

Book Reviews

The Closed Treatment of Common Fractures, *John Charnley*; Urological Aspects of Spinal Cord Injuries, *George C. Prather;* Neoplasms of Bone and Related Conditions, *Bradley L. Coley;* Diseases of the Foot, *Emil D. W. Hauser;* Physiology of Motion, *G. B. Duchenne;* Gliedmass Enamputationen und Gliederersatz, *W. Marquardt;* Muscles: Testing and Function, *Henry O. Kendall* and *Florence P. Kendall;* Osteogenesis Imperfecta, *Knud Stakemann Seedorff;* Pye's Surgical Handicraft, *Hamilton Bailey* (Editor) 757

Books Received 764

Index to Volume 765

Contributors' Addresses xxx

The Journal of
Bone and Joint Surgery

EDITORIALS

THE TWENTIETH CENTURY

On the first day of the New Year—the mid-point of the century—we should reflect both on the future and the past. The destiny of orthopaedics, like its history, will depend upon close and sustained international collaboration. It is a symbol of the unity already achieved in the English-speaking world that the leading editorial in this British issue is written by the American editor.

THE BACKGROUND OF A HALF-CENTURY OF PROGRESS

With this issue of *The Journal* there comes to a close the first half of the twentieth century. It is appropriate that its pages should be devoted to an account of progress in orthopaedic surgery during these eventful years. Peculiarly fitting is it that this record of brilliant achievement should appear in a British number, so many and great have been the contributions of Britons to the transcendent developments of this period, not only in medicine but in the natural sciences.

It is evident that the progress of modern surgery has been part of a general advance in which every division of medicine has pressed vigorously forward, while the development of medicine as a whole has, in turn, been part of an amazing progression on a far wider front, in which all the natural sciences and technology have shared, with a power almost beyond the imagination. During these years and much of the last century there has been wrought a broadening of man's intellectual horizon; " the whole conception of the natural Universe has been changed by the recognition that man, subject to the same physical laws and processes as the world around him, cannot be considered separately from the world, and that scientific methods of observation, induction, deduction and experiment are applicable, not only to the original subject-matter of pure science but to nearly all the many and varied fields of human thought and activity " (Dampier 1949). In the nature of scientific methods and in the development of their present scope may be found some of the reasons for this profound change of viewpoint and for the extraordinary twentieth-century achievements in science and technology, in both of which medicine has so fully shared.

In its present development scientific observation is a process of perception by which the trained observer seeks new facts. Usually he attempts to augment groups of phenomena already established. By concentrating his attention on a limited number of groups, he is able to sharpen his vision for the detection of matters that may be passed unnoticed by the ordinary observer. In his observations he subjects himself to a rigid discipline, endeavouring to discriminate the facts as they are from his own preconceived ideas which result from the framework of past inferences, deeply ingrained in his mind through the intimate association of perception and inference. His observations, as nearly as possible factual, are then recorded. From given facts the scientist passes by inductive reasoning to the formulation of hypotheses, assumed generalizations, or concepts which he devises through imagination and insight to explain the relations of the phenomena that he has recorded. He endeavours to invent and

apply controlled observational and experimental tests of the validity of his concepts or hypotheses, discarding those suppositions which do not stand up, until he finds one which remains unscathed after all tests have been applied which his imagination can suggest. His next step is—mathematically or by other logical inference—to deduce the practical consequences of his concept, whether particulars or general principles. These deductions, in turn, he tries to verify experimentally. When one of his hypotheses has been proven to be in accord with all known facts, whether antecedent or consequent, it has attained the rank of a theory.

Through the invention and testing of concepts, superficial relations of phenomena are discovered which may serve as stepping stones to the understanding of those more profound relational classifications of facts which we call the Laws of Nature: " with distance and time to work with, and their derivative velocity, Galileo, after one failure, guessed the right relation between the velocity of a falling body and the time of the fall, deduced its mathematical consequences and verified them experimentally. Adding the concept of mass, implicit in Galileo's work, Newton formulated the laws of motion, and deduced from them the science of dynamics, abundantly verified by observation and experiment " (Dampier).

The tenuous beginnings of the scientific method are traceable to early historic times. Since " the development of mathematics is also the development of the language of science " (Conant 1947), its evolution is important to an understanding of the growth of the methods of science. Geometry had its origin, probably in Egypt, in the empirical rules of land surveying, developed to meet the need of re-establishing landmarks lost by the seasonal overflow of the Nile. Later, over several centuries, it was cultivated by the Greeks into a science complete in itself, the monumental contribution to the development of general science which it has since proven to be. The Far East conquests of Alexander the Great led to important contributions to Western mathematics in arithmetic and the rudiments of algebra and trigonometry, which continued intermittently into the Renaissance. During the sixteenth and seventeenth centuries, stimulated by interest in astronomy and physics, giant strides were made in mathematics and instrumentation; the achievements of such men of genius as Copernicus, Tycho Brahe, Kepler, Galileo, and Newton have been proclaimed so often as to be almost common knowledge. In the latter part of the seventeenth century, Newton and Leibniz independently invented the infinitesimal calculus which forms the basis of modern mathematics. During the next two centuries mathematics " enjoyed its share in the prosperity of a more scientific age" (Sedgwick *et al.* 1939). The progress of mathematics in the nineteenth and twentieth centuries has kept pace with the epochal developments in the other fields of science; in biophysics and biochemistry it has been virtually indispensable; the mathematical laws of probability have played an important part, not alone in the rationalization of statistics and the estimation of error in measurements, but also in the investigation of a wide range of scientific problems.

Among many famous mathematicians of the twentieth century must be mentioned Planck, whose quantum theory (1901) has been so valuable in explaining relations of radiation and other mysteries in the new physics, Bohr in the mathematics of the structure of the atom, and Einstein, whose theory of relativity (1915) has revolutionized centuries-old concepts of space and time.

Of the quantitative method in scientific synthesis and analysis, Lord Kelvin wrote: " I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be."

In the search for pure knowledge, scientific investigation has often led to many inventions which, in turn, have held the clues to the discovery of new concepts and deeper insight, and

marked the beginnings of a tremendous acceleration of scientific progress. Faraday's researches in electromagnetism led to the invention of the dynamo, which evoked a vast array of technological and purely scientific problems and solutions. Maxwell's studies of electromagnetic waves made possible the discovery, fifty years afterwards, of " wireless," with its train of consequences leading to radar. Pasteur discovered that fermentation, putrefaction, and infectious diseases were due to living micro-organisms, thus paving the way to immeasurable practical applications in public health and surgery, with incalculable sequels.

In 1859 the *Origin of Species* was published. At once basic concepts were shaken; over the years, profound changes followed in the scientific outlook of the century. For example, to accept the Darwinian theory of evolution it became necessary to revise the old concept of matter—according to which matter was inert, a totally dead substance. If life was to have origin in matter, matter as cause must hold the potentiality of life, the effect. Otherwise life could not understandably originate in matter. The evidence to-day is that, instead, matter is preponderantly a concentration of high-velocity energy. The theory of evolution, as a creative process, has stood the test of time. It has been an important factor in the developments which followed in physics, chemistry, biology, and of course medicine, while perhaps no less directly influencing philosophy, psychology, sociology and religion.

The new epoch in physics may be said to have begun with Röntgen's accidental finding of X-rays in 1895, and in 1896 Becquerel's discovery of radioactivity. While the groundwork had been laid during the preceding fifty years, progress in the physical sciences became enormously accelerated. The rapid advance which followed may be traced through the contributions of many and great investigators, among whom were J. J. Thompson, Rutherford, Curie, Milliken, Moseley, Aston, A. H. Compton, Richardson, Langmuir, and Bush. Having arrived at the structure of the atom and the release of the stupendous energy of matter, progress is still in full stride, nor are there signs of abatement.

From their beginnings the natural sciences have advanced unevenly. The frontier has been made to yield over limited salients, usually through the work of intellectual giants rather than, as popularly conceived, by accident. Other salients are formed. Then follows a filling-in of the gaps between, as the new concepts and new outlooks of these salients interact and suggest new observations and new experiments, which in turn lead to new concepts and viewpoints. The intersalient areas may be dominated by one or more great men or they may be filled in through the labours of many scientists, each of whom may independently contribute a share.

Medicine has been a vigorous participant in the growth of science. In its own pattern of progress, scientifically and technologically, may be traced a parallel with that of pure and applied physics, chemistry, and biology. The scientific spirit of freedom, accuracy, and creativeness has become a dominant characteristic of medical training and of the thought of the modern surgeon. Hospitals have become centers of scientific investigation and teaching as well as institutions for the proper care of the sick. Medicine is being practised as an art and creatively developed as a science, not alone physical but also sociological. Centuries before it was rationally practised in the temples of Aesculapius at Epidaurus, Athens, Cos, and other centers, the healing art had developed to a point where, at the southern end of the " fertile crescent," in what seems to have been one of the cradles of civilization, there existed accurate descriptions of physiological and pathological processes correlated with the clinical features of a number of diseases with which we deal to-day. For centuries various surgical procedures had been practised, such as cranial trephine, circumcision, Caesarian section, lithotomy, and others. While the knowledge of early anatomy had been stimulated by embalming, practised for religious reasons, and by dissections, carried out in the search for omens in the pursuit of magic, the Greek Alcmaeon of Crotona, about 500 B.C., seems to have been among the first to perform, as a scientific observer, dissections and animal experimentation in the search for knowledge of anatomy and physiology. Medicine, in the earlier Greek

civilization, clearly had origin in religion and was held to be a branch of philosophy. Later, medicine reached its zenith in the teachings of Hippocrates. Free from superstition, the Hippocratic school recognised in disease a process subject only to the laws of nature, and taught the natural history of disease as it is derived from accurate observation and careful interpretation of symptoms. Treatment was based on the fundamental concept that the healing power of nature was primary and the physician's responsibility was to further nature's ends—an influence which has extended over two millennia.

In the earlier years of the Alexandrian Museum, contributions were made to the progress of anatomy and physiology through the studies of Herophilus and Erasistratus in which structure and function seem to have been inseparable.

In the second century, Galen, a graduate of the Alexandrian school of anatomy, added substantially to knowledge of the relations and actions of the central nervous system, first suggested the myogenic theory of the heart beat, and established the function of a number of the peripheral nerves—all by animal experimentation. He may rightfully be considered the founder of experimental physiology. Thereafter, up to the time of the rise of the medical schools of Salerno and Bologna in the eleventh and twelfth centuries, when scientific interest in anatomy was reawakened, the lasting contributions to the development of medicine seem to have been of Moslem origin and largely in the nature of descriptions of disease.

With the Renaissance begins a rapid succession of great men and great contributions to the advancement of medicine. Subservience to the authority and dogma of scholasticism, to the traditions of Moslem science, and to Greek doctrine and philosophy steadily gave way before the method of observation and experiment; more was sought the "how" of the sequences of nature and less their "why."

In the same year, 1543, in which Copernicus published his *De Revolutionibus Orbium Coelestium*, Vesalius laid the foundation of modern anatomy in his complete and monumental *De Humani Corporis Fabrica*; the one, as a contribution to basic medical science, was hardly less important than the other, with its reformative analysis of the astronomical relations of the earth and the application of mathematics to their solution. During the same century Ambroise Paré, master surgeon, indefatigable student and investigator, immortal author of "*je le pensay, et Dieu le guarist,*" established hemostasis by ligature, abolishing the cautery and boiling oil in the arrest of wound hemorrhage.

No less revolutionary in its effect upon the intellectual outlook was the discovery, through the genius of Harvey, of the circulation of the blood, published in 1628 as *De Motu Cordis*. Soon to follow was Malpighi's demonstration of the passage of corpuscles through the capillaries connecting the arteries and veins in the lung of the frog by means of a "two-lens" microscope, and van Leeuwenhoek's observation of the same connection, as observed in the tails of young fish and tadpoles. Knowledge of the lymphatic system was acquired contemporaneously through the researches of Aselli, Pecquet, Bartholin, and Rudbeck (Castiglioni 1941). These great contributions to physiology established the intermediation of the blood and lymph systems in nutrition and helped to prepare the field for the later epochal developments in physiological biophysics and biochemistry.

As Vesalius was the founder of modern anatomy, Harvey, through observation and experiment, established modern physiology. By the same methods Harvey also contributed substantially to embryology. A few years later Sydenham re-established the fundamental concepts of Hippocrates—the healing power of nature and the observational study of disease. In so doing, he became the founder of modern clinical practice. About this time, at Padua, Morgagni in his *De Sedibus* laid the foundation for modern pathological anatomy; John Hunter gave to surgery its place as one of the major divisions of scientific medicine, founding it squarely upon anatomy, physiology, and pathology. The intersalient areas between the great salients created by the genius of Vesalius and Harvey, Morgagni and Hunter, and the epochal work of Sydenham were soon to be explored by such great men as Boerhaave of

Leyden, von Haller at Göttingen, and many others to follow. Significant in another field was Jenner's vaccination, a little later, for it led to the creation of the new subject of preventive medicine.

During the first half of the last century, physiology became established as one of the natural sciences firmly based on physics and chemistry. Among its great builders were Magendie at Bordeaux, Johannes Müller in Berlin, and a little later Claude Bernard. During the latter half Virchow stood pre-eminent in pathology.

We have passed along the corridors of antiquity, catching a fleeting glimpse of the intellectual giants whose labours and achievements culminated in the vast accumulation of present knowledge and the more complete formulation of those procedures which are based on ever-changing concepts and viewpoints, and which we call the methods of science. To complete our picture of the earlier background, we should also recount some of the other more recent and important developments in medicine of the past hundred years. Following the pioneer work of Pasteur, bacteriology and immunology developed rapidly into an important basic scientific field through the contributions of such investigators as Koch, Weigert, and Ehrlich. That sepsis resulted from contamination, especially contact inoculation, was demonstrated independently by Holmes and Semmelweiss, who advocated scrupulous surgical cleanliness and the avoidance of contact. Shortly afterwards, Lister made his epochal contribution of antisepsis, later to be modified in the form of asepsis by steam sterilization and the use of rubber gloves. Anaesthesia was introduced by Morton in 1846, having been demonstrated both clinically and by animal experimentation. One discovery and its consequences made surgery safe; the other made it feasible through the abolition of pain. With these monumental inventions must be included a third, both diagnostic and therapeutic—Röntgen's X-rays.

In the more recent background of orthopaedic surgery is an amazing panorama of discovery and invention. All of the basic medical sciences have been astir, stimulated and productive through the interaction of their own new concepts and fresh outlooks with those of related fields of investigation. As a result, the advance has been by geometric progression, vividly exemplifying the effectiveness, in scientific investigation, of multiple related hypotheses (Gilbert 1886). Among many new and highly significant contributions should be mentioned here the advances made in the knowledge of water balance, of crystalloid and colloid osmotic equilibria between intracellular and extracellular fluids, of the body's mechanisms of acid-base equilibrium, and of nitrogen balance.

As a result of advances in the biochemistry and biophysics of internal respiration, the mechanisms of serious oxygen impoverishment of tissues are better understood and may often be avoided, notably those due to stagnation of blood and especially in such vital structures as the central nervous system, liver and kidneys from shock, hemorrhage, during anaesthesia, and as a result of vasospasm. One need not wonder at the effects of infections and of toxins from trauma and other sources which inhibit cellular oxidation.

The importance of vitamins in nutrition, wound healing, the coagulation of blood, in bone growth and modelling and in resistance to infection is widely recognised.

The bacteriostatic action of the sulphonamides and later the antibiotics, led by penicillin, has profoundly altered surgical practice.

Incalculable benefits have resulted from progress in the knowledge of coagulation and of preservation of the blood. The blood bank has become indispensable, immeasurably enhancing effectiveness in combating traumatic shock and expanding the field of operative surgery. The use of dicumarol and the action of heparin have been important adjuncts in the control of embolism and post-operative thrombosis. Fibrin foam and soluble cellulose with thrombin have proven effective hemostatic agents.

Better understanding of the mechanism of central and autonomic reflex actions, including adrenergic and cholinergic effects, has led to deeper insight into the manifestations of various

ELLIOTT GRAY BRACKETT, Editor of *The Journal of Bone and Joint Surgery*, 1922–42.

disorders such as cerebral palsy, myasthenia gravis, and those of vasomotor origin, with significant improvements in treatment.

This account could be continued almost endlessly, and still justice could hardly be done to each achievement and its importance.

As early as the sixteenth century, men of scientific interest became associated with one another in societies and academies, formed to promote discussion and for the advancement of science. Among the earliest was the *Academia Secretorum Naturae* of Naples, which became known in 1560. In 1662 there was incorporated The Royal Society; in 1666 the *Académie des Sciences* was chartered. The *Journal des Savants*, Paris, 1665, seems to have been the first of the scientific periodicals; in the same year it was followed by the *Philosophical Transactions of the Royal Society*. To-day each one of the arts and sciences has its national and local organizations. In affording opportunity for discussion, the acquiring of perspective, the formulation of general opinion and, in their periodicals, providing opportunity to present the contributions of their members, these societies have contributed immeasurably to progress. Recently have come into being the great international scientific bodies.

A tendency to national isolation may be traced in the history of medicine as in that of pure science, in part the result of tradition and authority, of the difficulties of travel and, to a degree, the barrier of language. To-day we may number among the incalculable benefits of modern technology the ease of travel and intercommunication among medical men of different nations.

In the advancement of orthopaedic surgery The Journal of Bone and Joint Surgery has long been privileged to play a part, both in the national developments of the specialty and in reflecting those broader spheres of influence which result from the interaction of national concepts and viewpoints. We are especially indebted to E. G. Brackett, Editor from 1922 to 1942, for his fruitful labours in shaping *The Journal* to these ends, and more recently to our British Editor, Sir Reginald Watson-Jones.

That the continuation of the present plan of collaboration of British and American orthopaedic surgeons in the joint publication of *The Journal* has recently been approved, so overwhelmingly, by both national groups, attests the soundness of the principle of international co-operation which was involved.

In the scholarly essays which follow in this issue will be found, fittingly recounted, the story of the splendid achievements of orthopaedic surgery during a half-century of progress. In the words of Sir Thomas Browne, *Religio Medici*, 1642—

Search while thou wilt, and let thy reason go
To ransom truth e'en to th'abyss below;
Rally the scattered causes, and that line
Which nature twists, be able to untwine;
It is thy Maker's will, for unto none
But unto reason can He e'er be known.

WILLIAM A. ROGERS.

REFERENCES

CASTIGLIONI, ARTURO (1941): A History of Medicine. New York: Alfred A. Knopf, 520.
CONANT, JAMES B. (1947): On Understanding Science. New Haven: Yale University Press, 26.
DAMPIER, Sir WILLIAM (1949): A History of Science. New York: Cambridge University Press, 200, 466.
GILBERT, G. K. (1886): The Inculcation of the Scientific Method. American Journal of Science, **131,** 284.
GILBERT, G. K. (1887): Special Processes of Research. American Journal of Science, **133,** 452.
SEDGWICK, W. T., TYLER, H. W., and BIGELOW, R. P. (1939): A Short History of Science. New York: The Macmillan Co., 383.
SMUTS, J. C. (1926): Holism and Evolution. New York: The Macmillan Co.

THE DAWN OF SURGERY

In which age of surgery would you choose to have lived—the age of John Hunter who was unaided by the microscope and had no knowledge of cells but by deductive reasoning and the experimental approach laid the foundations of a science; the dramatic era of Pasteur and Lister when hospital gangrene was understood and surgical infection was controlled; or the controversial age of Morton and James Young Simpson when oppositions were overcome and the agonies of surgery were relieved? Would you have assisted Macewen in the first successful bone-grafting operation; or been a disciple of Hugh Owen Thomas in his crusade; or lived at the turn of the century with Röntgen and the Curies, sharing the early triumphs of abdominal surgery with Billroth, Mikulicz, Murphy, Lawson Tait and Mayo Robson, or the later successes of reconstructive bone surgery with Arbuthnot Lane, Lambotte, Hey Groves and Albee? Would you have been a pathologist working at the London bench of Fleming when penicillin was discovered; or one of the first British anaesthetists to become clinical pathologist of the operating team and accept responsibility for the safety as well as the comfort of the patient; or a pioneer of thoracic and cardiac surgery, victoriously disproving earlier beliefs that the limit of territorial invasion had been reached? Or would you have chosen the very age in which we live, and chosen to be young in it—acknowledging both the achievements of the past and the promises of the future?

When survival of the human race has depended on movements of an ice-cap during one million years, and on the demands of evolution throughout one thousand million years, it seems impertinent to believe that progress of great significance could have been made in fifty years. Nevertheless it is true that in this very brief span there is a record of greater achievement and greater promise than at any other time in the millions of years of our history.

It is little more than half a century since medicine emerged from the occult influence of the Middle Ages with its magic touches and magic potions. To-day it is a science with the precision and accuracy that has been gained from cytological, radiological, biochemical, physico-chemical, epidemiological and sociological study of disease; from the identification of vitamins, isolation of bacilli, cocci, rickettsiae and viruses, and the discovery and synthesis of antibiotics; from recognition of the possibilities of surgical intervention by which to relieve not only disease, deformity and pain, but evena wareness of pain and emotional reaction to it, so that suffering as well as pain may be controlled; and from the remarkable advances in surgical technique, medical therapeutics and laboratory control that have dispelled the fears of virulent infection, the anxieties of surgical shock and the perils of anaesthesia.

There is some danger that in this development of a science there may have been neglect of the art. Some surgeons, in accumulating a welter of laboratory reports are almost ready to ignore the symptoms of which the patient complains, placing absolute reliance on pathological investigation and scientific data without the tempering of clinical judgment and common sense, paying greater regard to thalamotomy and leucotomy than to human and sympathetic understanding, and striving to be scientists at the cost of forgetting to be doctors. Even the science of psychosomatic medicine, based on the work of Sigmund Freud fifty years ago, must fail unless it is coupled with the art of Plato and his concept of the indivisibility of "physicians of the body and physicians of the soul." Every surgeon, being a scientist, must also be a doctor.

The promise of the future is almost without limit. Chemotherapy is in its infancy and there seems little doubt that the disappearing mortality and morbidity of meningitis, pneumonia, pyelo-nephritis, osteomyelitis and wound infection will soon be joined by similar control of tuberculosis, leprosy, rickettsial infections and perhaps virus diseases. We are only beginning to recognise the infinite possibilities of hormonal treatment. The cure of rheumatic disease, periarteritis nodosa, rheumatoid arthritis, acute gout, disseminated lupus, allergic skin disorders, bronchial asthma, hay fever, and acute uveitis with glaucoma is almost assured; and we may soon learn to influence mesenchymal growth and the vitality

of fibroblasts and osteoblasts, to control the rate of healing of wounds and the time of union of fractures, to prevent the development of fibrosis and contracture, and even to control the degeneration of hyaline cartilage. There will be increasing knowledge of the factors that influence embryonic development; we may even learn to prevent congenital deformity and hereditary disease. And who can doubt that solution of the cancer problem is in sight? Consider the metabolic analogies of carcinomatous growth and the miracles of the last decade—oestrogen in its effect on carcinoma of the prostate; cortisone in its control of monocytic leukaemia; the chemical link between cortisone and the male and female hormones; and the hushed words that are being whispered of the influence of vitamin B12. The cure of cancer is almost, though not yet quite, within our grasp.

This is indeed the Dawn. Never since the days of Hippocrates could a young man say with greater conviction that this is the age he would have chosen. This is the age in which to live, and in which to be young. "Bliss was it in that Dawn to be alive, But to be young was very Heaven!"

REGINALD WATSON-JONES.

THE EDITORIAL OF A.D. 2000

The year A.D. 2000—the year in which this editorial is written—is undoubtedly of deep significance to the human race, and it is not surprising that in almost every sphere of activity the "progress" of the last fifty, hundred or one thousand years is at present under review. On the other hand Nature is quite unaffected by this momentous date; the snowdrops are still blooming under the beeches as they have done from time immemorial; and no doubt when the art of orthopaedics has been brought to an equivalent state of perfection and simplicity we shall be content to let it bloom naturally year by year without constant review of progress and perpetual seeking of change.

Meanwhile it is our duty to review only the last fifty years for, in 1950, a comprehensive survey of the previous half-century was published in this *Journal* which so recently had achieved full representation of all the British and American nations. We have every reason to be proud of the energy and vision of the men who produced that survey. The picture they painted of orthopaedic surgery was very different from the one we see to-day but, lest we feel self-satisfied or vainglorious, let us remember the difficulties under which they laboured and the benefits we have gained from their mistakes.

Not all the changes that have been made in orthopaedics since 1950 are necessarily improvements—and not all of them have come from within the speciality itself. It is true that there have been many revolutionary changes in surgical technique. The linear jet which divides tissues microscopically and at the same time seals small vessels has replaced the knife; the tourniquet has been made unnecessary; the theatre trappings of gowns, gloves, sterilizers and scrub-units have disappeared; inhalational and intravenous anaesthesia has been replaced by electronic trances; operative shock has been eliminated; and the speed and safety of operations is now such that surgical intervention presents no difficulty in the ninth and tenth decades of life. But these advances in technique have not materially affected our practice or principles; and although many of the demands made upon us have been changed by discoveries and advances outside our speciality, our responses are much the same.

Tuberculous disease of bones and joints has largely disappeared, not because of any new discovery but because social scientists have forced action upon successive governments and made them implement the methods of prevention that were known much more than fifty years ago. For the treatment of the occasional case of tuberculous disease that still occurs we have to thank the biochemists for their therapeutic agents. No longer are little children bound to steel frames for two, three or more years; indeed there would be severe

criticism to-day if complete cure and full recovery of function of the affected part was not regained within six months.

Orthopaedic surgeons played little part in discovering the cause of malignant disease—and the profession as a whole can hardly feel proud of the use that has been made of that discovery. It is true that metastases are now almost unknown; but throughout the last twenty years the occurrence of primary foci of malignant disease could have been prevented. It needed only the courage of politicians—exactly as had happened earlier with tuberculous disease—to allocate the necessary expenditure and enforce the necessary measures of protection. No doubt the hand of authority will soon be forced by the weight of public opinion, and the appropriate facilities will be made available. Thus it was that deficiency diseases were controlled more than half a century ago so that rickets, for example, had entirely disappeared by the year 1960—but only as a culmination of the activities of the previous forty years.

Just as in 1950 the control of vitamin-deficiency diseases appeared so obvious that few reviewers commented upon it, so to-day the control of hormonal-deficiency diseases is so well recognised that we forget the horrors of rheumatoid arthritis which passed so long ago from the sphere of orthopaedics. Nevertheless the incidence of degenerative osteoarthritis has increased and little advance has yet been made in our efforts to prevent the wearing of articular cartilage and preserve the elasticity of ligaments and tendons.

The incidence of bone and joint injury has increased despite the development of covered one-way roads alongside every railway track and the radar-protection of helicopters; but this is perhaps not surprising when we recall how static was the population of fifty years ago and how few members of the community then indulged in travel. Fortunately this increase in the frequency of bone fractures has been unimportant because intramedullary fixation with thermostatic, homoplastic agents injected directly into the fracture site, cancellous in their form, setting to the resilience and strength of steel, stimulating callus formation, and being resorbed in that process, has permitted immediate weight-bearing in nearly every fracture. Similarly the problem of the severed tendon has been solved, though complete success has not yet been achieved in the case of nerve injuries.

Perhaps one of the greatest advances, which to-day seems so obvious and so little worthy of comment, is the change in the incidence of congenital and familial disorders. It was in the fifth decade of this century that the importance of early embryonic environment as a factor in the origin of congenital deformity was first elucidated; and to-day we pay respect to the gallant efforts of our forefathers who perforce spent so much of their time in treating congenital dislocations of the hip, congenital club foot, and other deformities that are seldom seen to-day except in our museums.

Attractive though it would be to envisage the likely changes of the next half-century, such a flight of fancy is not within the scope of this Editorial and we must content ourselves with hoping that our successors may enjoy peace and progress similar to that which has been vouchsafed to us.

BRYAN MCFARLAND.

ORTHOPAEDIC SURGERY IN THE UNITED STATES OF AMERICA

LEO MAYER, NEW YORK, N.Y.

I—THE EARLY YEARS

Forty years ago an interne on one of the services of a large New York City hospital, when discussing his ambition of specializing in orthopaedic surgery with a leading neurologist of the city, a man well versed in the actualities of medical practice, was given this advice: " Don't! You'll be wasting your surgical talent. Flat feet, crooked backs, and a few cases of joint tuberculosis: that's what you may expect." Though, as we shall see shortly, orthopaedic surgery at that time actually embraced much more, the neurologist was expressing truthfully the dominant concept of the speciality. What has occurred during the past half-century to change the accepted status of orthopaedic surgery from one of scant, grudging recognition to that of one of the major surgical specialities ? That is the subject of this paper.

The modern era of orthopaedic surgery in America begins in January 1887 when at the instigation of Dr Virgil P. Gibney and Dr Newton M. Shaffer, both of New York City, a group was called together to consider the advisability of organizing an orthopaedic association. When after discussion a vote was taken, ten were in favor, two were opposed and two cast blank ballots. Following the opinion of the majority, a rule of democratic procedure to which the Association has steadfastly adhered, the first meeting of the new society was scheduled for June of that year at the New York Academy of Medicine. It was to be called " The American Orthopaedic Association." Its purpose was " the advancement of orthopaedic science and art." Gibney was elected chairman; Robert Lovett of Boston served as temporary secretary and was replaced in June by Lewis H. Sayre. Thirty-five men were invited to become members; they may well be known as the " founding fathers." For the next fifteen years the proceedings were published in a yearly volume known as *The Transactions*. These publications reflect accurately the thought and the achievements of this early period. They show clearly the struggle between two concepts: the old, emphasizing the importance of braces and the mechanical phases of therapy; the new, insisting on the inclusion of surgery and stressing the necessity for more accurate knowledge of the etiology and pathology of disease. This, the modern view, was well expressed by A. M. Phelps, who in his presidential address (1894) said: " The orthopaedic surgeon of the future will be a man who has been thoroughly schooled in all the departments of medicine, who will have a perfect knowledge of pathology, surgical bacteriology and anatomy." And by De Forest Willard (1890) of Philadelphia who wrote: " The true orthopaedic surgeon should be ready to treat, care for and carry a case through all stages, no matter whether the treatment requires the application of apparatus or whether it necessitates a serious surgical operation." And by A. J. Steele (1890) of St Louis who maintained: " The orthopaedist should first be a general surgeon." The opposition nevertheless fought a stubborn battle, which actually lasted in some quarters until the end of the first world war. A. B. Judson, president in 1891, insisted that when an amputation was indicated in an orthopaedic case, a general surgeon should be called in to do the surgery. Newton Shaffer pleaded for the orthopaedic surgeon to " specialize in mechanical therapy. . . . To mingle surgery and mechanics is to endanger both." Gradually, however, the new concept gained control as evidenced by the replacement of Dr Shaffer as chief of the New York Orthopaedic Hospital in 1898 by a rising young surgeon, Russell Hibbs, who proved conclusively that surgery and mechanics could be " mingled " with great advantage to both.

This insistence on surgery as an integral part of the speciality precipitated an inevitable fight with the general surgeon. Not that this was anything new: " The orthopaedist was

always at war with the general surgeon," said Phelps in 1894. " There never was a time when they could lie peacefully together in the same bed excepting like the lion and the lamb—one inside the other, and the poor orthopede was always inside." The conflict continued to be long and bitter; the orthopaedic surgeons have had to show their mettle and prove their case by the superiority of their results. Said Phelps: " The specialists won the battle in a fair fight upon the field of thought and the profession of medicine awarded them the victory." Gradually, almost imperceptibly, the scope of the speciality has widened by what might be termed the pragmatic method—" *If you can do the job, it's yours to do.*" As early as 1891, Gibney quoted the remark of a prominent general surgeon, "the next work on orthopaedic surgery will likewise tell us all about fractures and dislocations." But though the scope has widened, the original intent of orthopaedic surgery has remained constant. This intent was phrased with particular felicity by Royal Whitman in his presidential address in 1896: "Orthopaedic surgery is that division of surgery which treats of disabilities and diseases of the locomotor apparatus, and of the prevention and treatment of deformities of the framework of the body."

What were actually the " disabilities and diseases of the locomotor apparatus " which claimed the attention of " the founding fathers " during this early period ? Dr Samuel Ketch, the president in 1897, has given us an enlightening summary of the papers of its first ten years. Of 292 papers, 114 dealt with tuberculosis of the bones and joints. Of these, forty-nine were concerned with Pott's disease, thirty-five with coxitis and nineteen with the knee. Club feet came next in frequency with forty-three papers, then scoliosis with twenty and congenital dislocation of the hip with fourteen. There were nine dealing with rickets, seven with spastic paralysis, six with poliomyelitis and six with torticollis. There were seventy-nine unclassified, including outstanding contributions by Dr Whitman on flat feet (1889, 1895) and juvenile coxa vara (1894), by Townsend (1889) on acute arthritis of infants, by Brackett (1891) on atrophy in joint disease, by Goldthwait (1892) on joint lesions due to spinal disease, by Hodgen (1892) on neuritis involving the serratus magnus and rhomboids, by Robert Lovett (1897) on spondylolisthesis, by Taylor (1894) on infantile scorbutus, and by Park (1895) on acute infections of the bone. Certainly the range of topics is extensive, with only a few striking omissions: fractures, backache and bone neoplasms are scarcely mentioned. In 1897, however, appeared Whitman's paper " Fracture of the Neck of the Femur in Childhood," a signpost indicating the direction in which orthopaedic surgeons were to advance. In this study of ten cases, in none of which the diagnosis had been made at the time of injury, Whitman expressed the germ of his subsequent abduction method by this statement: " [reduction of this fracture] might best be accomplished by abducting the leg to the full." Even more significant is the comparative lack of attention to the X-ray. A number of skiagraphs were presented, but the vital importance of the discovery for orthopaedic surgeons seems not to have been fully appreciated. Even as thoughtful a student as Robert Lovett, in his presidential address in 1898 dealing with " Pathology in its Relation to Orthopaedic Surgeons," does not once mention the work of Röntgen, nor did he seem to envisage its meaning for the pathological knowledge he considered so important to orthopaedic advance. In his remarkable paper of 1900 dealing with the mechanics of lateral curvature he employed a variety of ingenious methods of investigation, but not the X-ray. The omission is all the more significant since Lovett was already thinking in terms of the X-ray in 1898, when with Cotton he employed roentgenology in his study of " The Anatomy of the Foot." No doubt the apparatus then available was so incapable of demonstrating fine bone detail that even the far-seeing Lovett failed to realize that the X-ray would help the development of orthopaedic surgery more than any other single discovery of the next half-century. The only orthopaedic surgeon of the day to stress its significance was Louis A. Weigel of Buffalo. He presented a paper in 1899 dealing with the diagnostic value of radiography. X-ray films were, he asserted, " not as fallacious as had been claimed." It is interesting to note that his paper did not elicit any discussion.

Returning to Dr Ketch's summary, it is obvious that the major interest of the Association centered in tuberculosis of the joints. The treatment was predominantly conservative. A fierce controversy raged between the adherents of the traction method, which was considered the " American way " (though according to Mr H. O. Thomas of Liverpool it originated with Mr James of Exeter in 1839), and the rigid fixation advocated by Thomas and by Robert Jones. There was also a clash of opinion regarding the treatment of abscesses, which occurred with great frequency (in 25 to 50 per cent of cases of coxitis). John Ridlon maintained with conviction: " Leave them alone. Not one in a hundred will cause trouble, if you just fix the joint." Others believed in aspiration, or, if this was not effectual, in open operation, excision of the abscess wall, and drainage. In cases of progressive coxitis, excision of the hip—an operation first performed by Lewis Sayre in 1854—was permissible. Some successes were reported, but according to Lovett their records showed a mortality close to 50 per cent and, of those who survived the operation, the functional results were bad. Only a few bold surgeons, like Harry Sherman of San Francisco, essayed the operation in the earlier stages of the disease, when the prognosis was more favorable. Attempts were made after mechanical excision of obvious pathological tissue to sterilize the field either with pure carbolic acid, left in place one minute, then neutralized with alcohol, or with 10 per cent iodoform in glycerin, or with iodoform gauze. None of these methods gained popularity, since a fatality was reported due to carbolic acid poisoning and the iodoform did not prove effective. Far more encouraging were the results in excision of the knee. These were in reality fusions of the joint. Joseph Bryant reported ten cases in 1891, all with good results except one, in which death ensued from Bright's disease. He urged therefore that the operation be done early, before kidney damage had occurred. The following year James Moore reported six cases, three of them complicated by extensive abscess formation; these patients recovered with ankylosed knees in good position. He concluded his excellent article with this illuminating statement: " It would be morally wrong under ordinary circumstances to operate at any early stage, because by proper orthopaedic treatment a movable joint could be secured." Phelps, Plimpton (1895) and Willard (1893) also reported cures by excision of the knee, but the concept of fusion as the treatment for a tuberculous joint had to germinate for many years before fruition. The idea of internal fixation in Pott's disease was suggested as early as 1891 by B. E. Hadra, who, having successfully wired the spinous processes for fracture of the cervical spine, advised the application of this method to prevent the deformity of Pott's disease. This, however, seemed to Reginald Sayre " such a novel departure that no one could pronounce judgment upon it at once." A good idea of the results of treatment can be gained from the paper of Lovett and Goldthwait (1889) dealing with " abscesses of hip disease." They found that during the five-year period 1884–88 inclusive, of 320 cases treated at the Children's Hospital, abscesses developed in seventy (23 per cent). Of these seventy, sixteen were dead and four dying; in seven cases the result was unknown. Approximately the same mortality was found by Gibney's five-year study of 150 cases of coxitis at the Hospital for the Ruptured and Crippled. Of these, 107 were classed as cured, eleven as dead, twenty-five as still under treatment, and in seven readmission had been advised. The adduction-flexion deformity which was evidently a frequent end-result was corrected by the Gant or the Adams subcutaneous osteotomy of the femur. Of this operation Ap Morgan Vance said in 1887: " I freely confess that I will break a man's femur subcutaneously with as little misgiving as to the outcome as I would divide his tendo Achillis." The first man to suggest the value of climatic treatment was George Packard of Denver, Colorado, who in 1898 reported the rarity of suppuration in his cases, which he attributed not to his treatment, but to " sunshine (320 clear days a year), pure air, rarity of the atmosphere, and the dry sandy soil." But the greatest impetus to the rational therapy of tuberculosis came from the pathological laboratory. Edward H. Nichols of Harvard, probably at the instigation of the Boston orthopaedic group, studied 107 tuberculous joints secured at the operating table or in the post-mortem room,

and in 1898 reported his findings to the Association in its longest communication (fifty-three pages). The occasion was dignified by the presence of Professor J. Collins Warren, head of the surgical department of Harvard, and of Professor William J. Councilman, head of the department of pathology. Both of them, as well as Gibney and Bradford representing the Association, expressed their appreciation of the significance of Nichol's study, which in reality laid the ground-work for our modern knowledge of the pathology of joint tuberculosis.

If the results in tuberculosis did not measure up to modern standards, the same cannot be said of club feet, the second in point of number of Dr Ketch's list of publications. Beginning with Bradford's paper in 1889, it is evident that the surgeons of that epoch thoroughly understood the pathology and treatment of the deformity, and that their results in all grades of deformity were excellent. Bradford's exposition could be used to-day as a lecture for medical students, so modern is it in every respect. The treatment of congenital dislocation of the hip, however, was in its earliest transition stage. Hoffa and Lorenz both attended meetings of the Orthopaedic Association. Lorenz's first paper in 1894 dealt with open reduction and explained his method. His second in 1896 gave a lucid description of the pathology and the " bloodless " method of reduction. Undoubtedly attempts were made to follow his technique, but according to Bradford's exhaustive paper in 1900 the technique by both the closed and the open method " lacked precision." He found that in all of his cases done by the " bloodless " method redislocation occurred; that the earlier cases treated by open operation were failures, but of the last group done in 1899 and 1900, six out of nine were successful. In 1902 he pointed out the danger of reluxation due to anteversion and advised a rotational osteotomy of the femur to overcome this element of the deformity.

The problem of scoliosis, according to Phelps, " rises before us each year like a spectre." He went on to say that despite all the claims made for sundry methods " I have yet to see (1900) the first case of lateral curvature of the spine, in which bone changes had taken place, cured by any plan of treatment known to the scientific world." Right he certainly was then—some think so even now—but our understanding of the mechanics of scoliosis was given a mighty forward surge in 1900 by the unusual research of Robert Lovett. Working on cadavers by the insertion of long needles into the vertebrae, and confirming his observations on living models, he was able to prove that " lateral flexion and torsion are associated parts of one compound movement and neither can exist without the other. That, however, in side-bending from the flexed position the torsion is diametrically opposite from what it is in the extended position, and that the spine follows the laws governing flexible rods in this regard." Again, " In flexion the bodies rotate toward the convexity of the curve, the spinous processes toward the concavity. In extension, however, the bodies rotate toward the concavity, the spinous processes toward the convexity of the curve." Lovett's observations still hold good. In the application of his results, however, to therapy he was not able to disprove the dictum of Phelps just quoted. The cure of scoliosis had to be handed down to future generations of orthopaedic surgeons.

In overcoming the deformities of infantile and spastic paralysis, Goldthwait (1895) and others employed tendon transfers, tenotomies and fusion operations, frequently with some measure of success. Dane and Townsend in 1903 were able to trace thirty-six out of fifty cases done at the Children's Hospital, Boston, and concluded that most of the tendon transplants gave poor results except where the tibialis anterior was transferred to the outer side of the foot for the correction of paralytic varus. Astragalectomy and fusion of the " tibio-astragaloid " joint, on the contrary, gave strong, useful feet.

The orthopaedic surgeons of this period varied markedly in their surgical prowess. Some of the leaders, like Newton Shaffer, did not even attempt major surgery. Others like Harry Sherman, Bradford, A. J. Steele, Royal Whitman, Phelps, James Moore, Joseph Bryant and De Forest Willard must have been expert operators, some of them with a remarkable flair for originality. Goldthwait (1900) reported thirty-eight operations for internal derangement

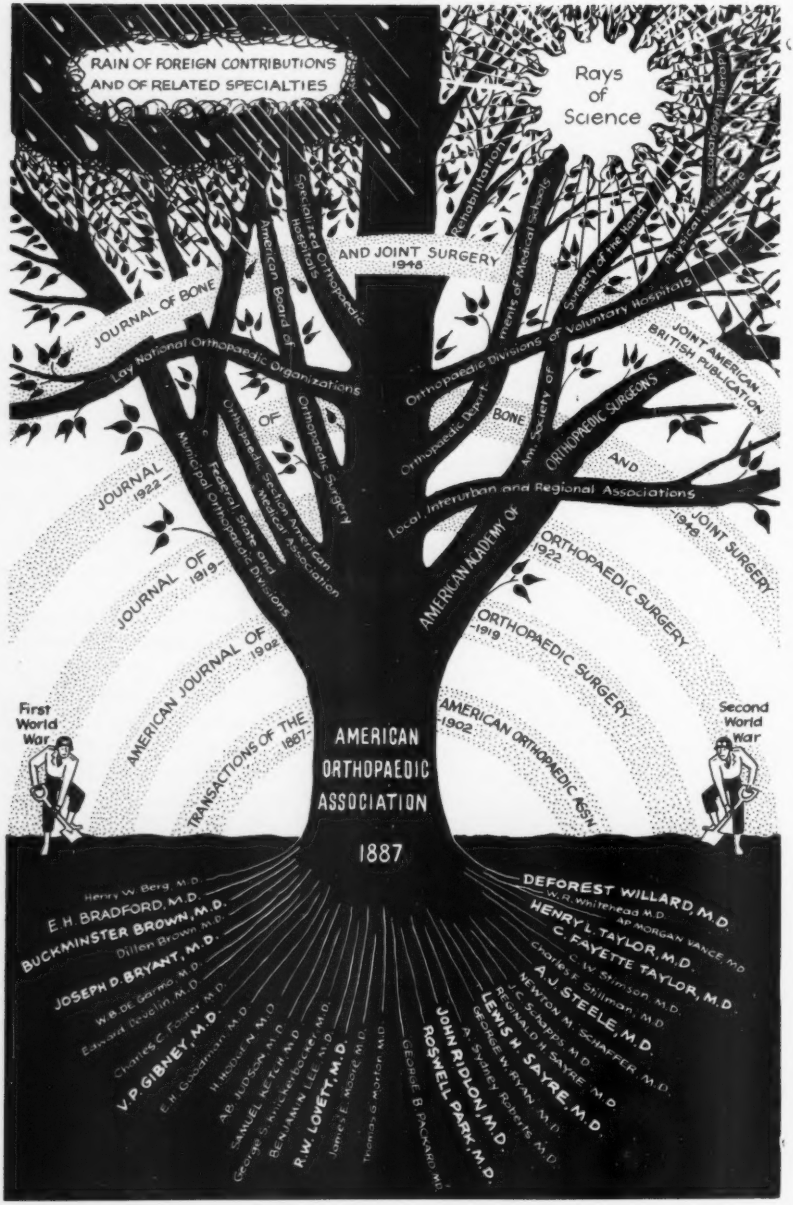
of the knee with a failure in only one case. Reginald Sayre (1893) demonstrated satisfactory correction of a club hand, due to an absent radius, by a shift of the ulna to the middle of the carpus. Phelps (1894, reported by D. Brown) secured normal motion by operating on an ankylosed jaw; and on three cases of posterior congenital dislocation of the humerus due to fracture of the posterior lip of the glenoid. De Forest Willard (1889) performed as many as six osteotomies at one time to correct rachitic deformities. Moore (1892), Bryant (1891) and others could resect a knee with accuracy and speed. Moore (1895) corrected severe "pigeon-toe" by a rotational osteotomy of the tibia. Bradford (1895) cured recurrent dislocation of the patella by an operation corresponding exactly to modern methods. Steele (1898) corrected a very severe hallux valgus by resecting part of the proximal phalanx of the big toe, exactly as in the Keller-Brandes procedure. Gillette (1898), G. G. Davis (1900) and Charles Thomson (1901) had the courage to operate on ununited fractures of the femoral neck and, after freshening the bone ends, to hold them in anatomical alignment by ivory pegs, nails or screws.

These men were accurate observers. Without the aid of X-ray, Royal Whitman (1894) worked out the pathology and symptomatology of adolescent coxa vara and slipping epiphysis. His papers on weak foot (1889, 1895), Morton's toe (1898) and congenital torticollis (1891) are classics which should be read and re-read by every orthopaedic student. Goldthwait (1894) made a fine study of the anterior arch by means of frozen sections. H. L. Taylor (1899) reported two cases of enlargement of the tibial tubercle (later called Osgood-Schlatter's disease). Without knowing anything about vitamins, they understood the dietetic causes of rickets (Charles N. Dixon Jones 1889) and infantile scurvy (Taylor 1894). Townsend made a masterly study of "Acute Arthritis of Infants" (1889) and urged early incision as the one hope. Brackett diagnosed subgluteal bursitis (1897) and cured it in three cases by excision of the bursa. Harry Sherman gave a good description of cleidocranial dysostosis. and McKenzie (Toronto) showed an amazing knowledge of psycho-somatic medicine (1901).

They were men of great industry as evidenced by their writings. Between 1887 and 1902 the fellows of the Association published 1,951 papers (H. A. Wilson, presidential address 1902); 583 of them appeared in *The Transactions*. Bradford wrote 105 papers, two text-books and numerous articles on the progress of orthopaedic surgery in the *Boston Medical and Surgical Journal*. Virgil Gibney wrote ninety-six papers, Roswell Park 100 papers and twenty-five clinical lectures, De Forest Willard 105 papers. Besides they gave much time to their hospital services as well as to private practice. They were enthusiastic about orthopaedic surgery and at times optimistic to the point of betraying an adolescent sentimentality. Said Steele in his presidential address (1893): "Had the infant Byron or the child Pope been born in our day, the club foot of the one would have been corrected, and the boss of the other prevented, and mighty genius which gave itself to satire and immorality would have sung ennobling verse and virtue's sweet refrain."

Of preventive medicine there was a faint beginning. Bradford tried to get shoes made according to anatomical designs; he also wrote an excellent paper on the seating of school children, and helped devise a good-posture chair. Of social service and rehabilitation there were no evidences in the publications available to the author. A sharp line apparently was drawn between the dispensary clientele and private practice. In 1891 Foster of Cambridge wrote: "I am not writing this article ('Extension in Bed in Spinal Caries') with reference to tenement house cases but a very different class—those who will meet us later in society and be known as our cases; also those people of means who come from a distance. For such the best is none too good." No voice was raised in protest: evidently further evolution was necessary before the sociological responsibilities of orthopaedic surgery were to be realized.

From the foregoing pages it is obvious that the American Orthopaedic Association represented a group of hard-hitting intelligent physicians who were determined to advance their speciality. Yet they were given only scant recognition in the medical world. In 1889 the members of the Association included four full professors, two clinical professors, one associate



GROWTH OF ORTHOPAEDIC SURGERY IN THE UNITED STATES, 1887-1950

professor, two lecturers and a few " assistants." Twelve universities were represented. In 1900 Harry Sherman devoted his presidential address to the topic of orthopaedic instruction in the medical schools. He discovered that of seventy-six universities only thirty-eight mentioned teaching orthopaedic surgery (just 50 per cent), whereas sixty had courses in gynecology, fifty-nine in pediatrics and fifty-eight in neurology. In only five colleges was the instruction both didactic and clinical. The Association was evidently doing its fair share of education, for of fifty-one active members twenty-six were engaged in teaching at twenty-three medical schools. Only slowly and by dint of education of the lay public as well as their brother physicians has orthopaedic surgery been able to attain its present status in the medical schools; and even now, as Dr LeRoy Abbot has pointed out, it is still unable to achieve universal recognition.

II—A BIRD'S-EYE VIEW

The period 1887–1902 came to an end when, at the urging of their president, H. Augustus Wilson, the members of the Association voted to discontinue *The Transactions* and instead to publish an *American Journal of Orthopaedic Surgery*. This step meant a radical transition from a self-centered and more or less provincial type of publication to one of world-wide significance. As early as 1893 Steele had advised publishing abstracts of all orthopaedic papers irrespective of their national origin. This method of imparting orthopaedic information was begun in 1902 in the pages of the Journal and kept up for many years. Through the change in the form of their publication, the inclusion of contributions from non-members and the printing of abstracts, not only the Journal but orthopaedic surgery in America took on new stature. Growth since then has been phenomenal. To its extraordinary development many factors have contributed: the development of roentgenology; improvement in surgical technique particularly in the field of bone-grafting, tendon-plasties, fusion operations and arthroplasties; increased interest in fractures, treatment of which has come more and more into the hands of orthopaedic surgeons; rapid advance in the knowledge of bone pathology, particularly of neoplasms; the successive development of numerous organizations all designed to further the advance of orthopaedic surgery; an increasing popular interest in the crippled child and the disabled adult; finally, two world wars and the obvious economic necessity for rehabilitation—these are but a few of the factors which come to mind. The development of orthopaedic surgery in the United States may be likened to that of a giant oak tree. The simile is not to be taken too literally; it serves only to characterise the unity, the complexity and the growth of American orthopaedic surgery. The roots, representing the thirty-five " founding fathers," spring deep from the soil of native mechanical ingenuity and surgical skill. From the great trunk—the first Association, founded in 1887—have sprung numerous branches, some of them, like the American Academy of Orthopaedic Surgeons, matching the parent trunk in importance. Other branches are seen representing the American Board of Orthopaedic Surgery, the orthopaedic section of the American Medical Association, the local, inter-urban and regional associations, and the American Society for Surgery of the Hand. Still other branches indicate the hospital development: the orthopaedic departments of the general hospitals, the specialized orthopaedic hospitals and crippled children's homes, the veterans' hospitals, the departments of physical medicine and occupational therapy, and the institutes for rehabilitation. There are branches to represent the national lay organizations such as The National Foundation for Infantile Paralysis, The Shriners' Hospitals, The International Society for Crippled Children, The National Association for Cerebral Palsy. Note also a most important branch—the orthopaedic departments of the university medical schools. The branch labelled federal, state, and municipal orthopaedic divisions includes the Army, the Veterans, the Children's Bureau, the State and City Departments of Health, hospitals and schools, above all, the great organization instituted by the Compensation Acts which have been so helpful to the injured workman, and brought a wealth of material to many important surgeons. Note the men in uniform who are cultivating the soil about the

tree. They signify the stimulating effect of the two world wars on the growth of the speciality. The figure on the left is in colonel's uniform to typify the activity of the two colonels who were at the head of the orthopaedic departments of the Army during World War I: Colonel E. G. Brackett in the Surgeon-General's office, and Colonel Joel Goldthwait overseas. The figure on the right wears a two-star cap to represent Major-General Norman Kirk, Surgeon-General of the Army during World War II, the only American orthopaedic surgeon to hold such a high rank. In both wars the high percentage of injuries of the extremities presented an enormous mass of material which the orthopaedic surgeon was better able to take care of than any other specialist. New problems were presented and solved: a host of younger men became enthused with the ambition to become orthopaedic surgeons. This led, as will be told later, to a great expansion after World War II of the system of orthopaedic residencies. In the upper left corner are visible the " life-giving rain of foreign contributions and of other specialities " such as neurology, pharmacology and pediatrics. From the outset The American Orthopaedic Association has invited foreign surgeons to attend their meetings and to contribute of their experience. Robert Jones, William Adams, Howard Marsh, Professor Hoffa of Berlin, Adolf Lorenz of Vienna are only a few of the distinguished men whose names appear in *The Transactions*. Through the years American orthopaedic surgeons have drawn knowledge and enthusiasm from colleagues in every part of the world. The debt of orthopaedic surgeons to the other branches of medicine is so great and self-evident that it does not require exposition here. In the right upper corner appear the rays of science shedding light upon the tree: from Lovett's early demonstration of the analogy between flexible rods and the spine with respect to the mechanical laws affecting both, from the epoch-making discovery of Röntgen, through the dramatic revelations of modern chemistry, physiology, bacteriology and pathology, down to the discovery of atomic fission, orthopaedic surgery has derived light and inspiration from science. In the background are seen five arcs, resembling rainbows, which represent the five periods in the development of our Journal:

1. *The Transactions*—from 1887 to 1902.
2. *The American Journal of Orthopaedic Surgery*—from 1902 to 1919.
3. *The Journal of Orthopaedic Surgery*—from 1919 to 1922.
4. *The Journal of Bone and Joint Surgery*—from 1922 to 1948.
5. *The Journal of Bone and Joint Surgery*, published jointly by the American and British Boards of Editors—from 1948 to the present.

The term "American" which has been used so frequently thus far has developed a peculiar connotation in connection with the phrase " American Orthopaedic Association." In reality it includes the orthopaedic representatives of Canada as well as of the United States, with a happy admixture during recent years of representatives of Cuba and Mexico. It is hard to differentiate between the activities of the Canadian members of the Association and those from the United States. Some of the most distinguished presidents of the Association have been Canadians and some of the most inspiring meetings have occurred in Canada. In deference, however, to the separate article on progress of orthopaedic surgery in Canada, I have endeavoured so far as possible to remain " south of the border " in my report of orthopaedic advances.

III—THE TRANSITION PERIOD

The years from 1903 to the end of the first world war may well be considered the transition period in the development of American orthopaedic surgery. During this time it acquired the general recognition which had at first been denied it. The period was characterized by: 1) great technical advances, based largely on more exact knowledge of pathology and of the anatomy and physiology of the musculoskeletal system; 2) increasing sense of responsibility to the community evidenced by the founding of large numbers of hospital-schools for crippled children, by the formation of hospital social service, by the growth

of the rehabilitation concept and by the development of compensation acts in many states; 3) the founding of numerous orthopaedic societies to instruct and to stimulate; 4) closer contact with foreign orthopaedic surgery through the medium of " exchange articles " and an extensive abstract system in *The American Journal of Orthopaedic Surgery*; 5) the expansion of orthopaedic teaching; 6) finally, and most important, by the inculcation of restoration of function as the essential purpose of orthopaedic surgery.

The period came to a dramatic climax with the advent of the first world war, when as John Porter said in his presidential address (1918): " I believe that a new era has begun for our speciality through the impetus given it by the demands of war." Overnight the medical profession, including the surgeon-general's office, realized that " the orthopaedic surgeon . . . from his peculiar training and experience . . . was specially qualified to deal with a large group of casualties, to conserve limbs and restore function, so as to return to civil life a multitude of soldiers who would be otherwise hopeless pensioners." (C. L. Starr 1918.) Had the war occurred fifteen years sooner, orthopaedic surgery could not possibly have played the important role which it did. What happened during these years to create the amazing development of the speciality ?

Probably no factor was more important than the extension of orthopaedic surgery to adults. E. G. Brackett in 1905, commenting on the enlargement of the orthopaedic field, said: " It is within the remembrance of even most of the younger men when the orthopaedic work was almost entirely confined to children. Now a large, if not the larger, part is devoted to adults, and in the work with them there has come relief to one of the most helpless forms of cripples." In the same year Virgil Gibney (1905) reported on the work of the adult orthopaedic ward of the Hospital for the Ruptured and Crippled over a two-year period; during this time 154 cases had been treated. He ended with a " plea for hospitals in which the adult cripple, male or female, may receive the same scientific treatment that has so long been meted out to the children." The inclusion of adults led to the study of new fields, hitherto unexplored by the orthopaedic surgeon: backache, fractures of the femoral neck, neoplasms, circulatory disturbances of the extremities, stiff painful shoulders, chronic arthritis, and the problem of mobilizing ankylosed joints.

Until the early years of the twentieth century cases of low back-pain had been considered under the vague category " lumbago." Goldthwait and Osgood in 1905 and John Dunlop in 1907 published papers emphasizing the pathological changes in the sacro-iliac joint and its ligaments as a cause of back pain. There followed papers by Meisenbach (1911), Freiberg (1913), Bucholz (1914) and many others dealing with the anatomy of the lumbo-sacral region, the pathological abnormalities and the clinical syndromes associated with them. Although the treatment was chiefly conservative and relied on rest, adhesive strapping, posture exercises and braces, Painter in 1908 advocated arthrodesis of the sacro-iliac synchondrosis. Blanchard and Parker in 1915 resected an impinging transverse process of the fifth lumbar vertebra with relief of pain; Roberts (1916) stressed gluteal myositis as an etiological factor. In 1916 Arnold of New Haven described his methods of fusion of the sacro-iliac and lumbo-sacral articulations. The gynecologist, the genito-urinary surgeon and the neurologist became interested in back-pain and indicated the frequency with which displacements of the uterus, or renal neoplasms or spinal-cord tumors caused back pain.

It is notable that some lines of therapy begun during this period—for example, fusion—developed more and more significance and became more and more popular, whereas the test of time resulted in less and less resections of transverse processes and fewer diagnoses of gluteal myositis. The development of bone-graft surgery by Fred Albee (1911) and by Russell Hibbs (1911) led to marked improvements in the technique of fusion which has now become so important in the operative treatment of low back pain.

Although previous to 1902 a few isolated articles on fractures had appeared and Whitman had written an important paper on fractures of the femoral neck in childhood suggesting the

feasibility of the abduction treatment, the great wave of orthopaedic interest in fractures began in 1902 with Whitman's description of his method of treatment by abduction combined with internal rotation and traction. His success in treating by this means fractures which had hitherto defied cure brought the orthopaedic surgeon into the field of fracture treatment. This was commented on by H. L. Taylor in his presidential address in 1908. Numerous articles then began to appear dealing with fractures of all the bones of the body from the atlas and axis down to the metacarpals. G. G. Davis of Philadelphia, Ryerson of Chicago, Mixter and Osgood, A. R. Shands, Packer, and Hammond of Providence, Hawley of Bridgeport and many others made contributions. Of particular importance were the papers of Albee and Henderson in 1914, the first dealing with treatment of acute fractures by the inlay bone graft, second, the treatment of ununited fractures by the same method. Hartwell in 1916 published eleven cases of fracture of the spine without paraplegia and was therefore one of the first to substantiate the views of Gillette presented in his presidential address of 1901. Cotton stressed the importance of reduction of os calcis fractures and published his well-known method in 1916. Cotton also made his own contribution to the treatment of fractures of the femoral neck by urging that they be impacted with a heavy mallet. Of particular orthopaedic significance was the paper of Robert Jones in 1913, " The Orthopaedic View of the Treatment of Fractures." " Every fracture," he said, " is potentially a deformity and if it becomes a deformity will lead to impairment of function." He concluded this article with these sentences: " The question for the modern surgeon is not whether operative treatment is to supersede manipulative . . . The problem before each of us is how we can improve our skill and technique in both manipulative and operative treatment and what means must we adopt in each individual case to give to our patients the surest, safest and most complete restoration of function." The quotation is of significance as emphasizing the concept of function which more and more has become a characteristic of orthopaedic surgery.

Typical of the expansion of the scope of orthopaedic surgery is the interest in circulatory disturbances of the extremities. Lovett's paper in 1906 on intermittent limping was followed in 1908 by Wilson's on Raynaud's disease, and in 1913 by Stern's on spontaneous gangrene in orthopaedic surgery. Further interest was stimulated by the pathological studies of Dr Leo Buerger, whose work on thrombo-angiitis-obliterans marked the beginning of an exact knowledge of the pathological changes.

The study of stiff painful shoulders owes much to Dr Codman of Boston, who as early as 1906 described the anatomy of the subdeltoid bursa, its relation to the supraspinatus tendon and its great significance in the etiology of pain about the shoulder joint. Walter Brickner's paper in 1912 contributed the idea of the abduction treatment as an important phase of therapy.

In many of the presidential addresses reference was made to the importance of arthritis; in the meeting of the American Orthopaedic Association in 1912 a symposium was held on the subject. Elliott of the Montefiore Hospital told about gastro-intestinal causes of arthritis. Nathan wrote of the treatment of toxic arthritis, Peckham on the importance of the abdomen as a factor in arthritis, Preiser of Hamburg voiced his theory of the incongruence of the joint surfaces as a cause of arthritis deformans. Leonard Ely brought out the fact that actually very little was known about the etiology of chronic arthritis. The treatment continued to be largely conservative and empirical, but in 1915 E. G. Brackett published his paper on the operative treatment of arthritis in which fusion was reported as a valuable method of cure, particularly in osteoarthritis of the hip.

Even more significant is the attempt to mobilize ankylosed joints. One of the pioneers was Dr William Baer of Baltimore who in 1909 published his preliminary report on the insertion of chromicized pig's bladder as an interposition material in performing arthroplasty. In 1918 sufficient advance had been made to warrant a symposium on the subject with fascinating papers by Baer, Henderson and Allison. The method had been applied to the

hip, the knee and the elbow with particular success. From the ranks of the general surgeons, Dr John B. Murphy of Chicago popularized arthroplasty and presented his methods at meetings of the American Medical Association as well as in numerous publications.

In the first part of this paper dealing with the early years, the strong interest of orthopaedic surgeons in tuberculosis was emphasized by the great number of papers devoted to this subject. During the period now under consideration occurred a remarkable advance. This was preceded by attempts to influence disease by the use of tuberculins, vaccines and serums. Ridlon in 1907 reported on the use of tuberculin, Freiberg in the same year on Marmorek's serum, Taylor on vaccines using the opsonic index as a means of control. Ogilvie, Mixter and Hastings, Plummer, Painter all reported their attempts, but without too much success. Leonard Ely in 1911 was the first orthopaedic surgeon to voice the inadequacy of the treatment of tuberculosis. He wrote: "This entire subject forms a reproach on surgery . . . Here is a frequent disease whose cause we have known for many years and whose effects we have had ample opportunity to observe. . . . Surely one might expect to find in regard to it among intelligent medical men a practical consensus of opinion, a weight of scientific opinion to which one may resort for light. . . . No such scientific opinion exists as to any phase of the disease." He stressed two main principles: immobilization of the joint and avoidance of secondary infection. Further: "The erection of hospitals in the affected cities for children with tubercular joints is an anachronism; glass sun parlors and closed wards are an abomination."

In the same year and within several months of one another Russell Hibbs of New York Orthopaedic Hospital and Fred Albee of the Post Graduate Hospital both published articles on fusion of the spine for Pott's disease. The concept of fusion which had been dormant for so many years finally became alive. Although the methods proposed by these two surgeons were quite different in technique, the purpose was the same, namely, to prevent deformity and aid in healing by a *physiological* method of internal fixation. This differed radically from Lange's method of implanting steel rods, published in 1910. Ryerson in 1914 characterized the Albee operation as "the acme of conservative treatment." In 1916 Albee was able to report on 539 cases of Pott's disease treated by the insertion of a tibial graft, with an arrest of the disease in 460, improvement in fifty-nine, unimproved in twenty, and deaths in nine cases—a great advance over previous statistics. In the same year Rugh reported twenty-six excellent results of the Albee operation in a series of forty cases. Rogers (1914) extended the idea of fusion to the knee and strongly urged early operation in the adult as the best means of stopping the progress of the disease. Ryerson (1914) favored ankylosis of the hip, but at that time there was still considerable difference of opinion on this problem by competent orthopaedic surgeons. Allison (1915) adhering to the view that healing with motion could be secured. Willis Campbell (1917) in two papers urged heliotherapy as an important adjuvant.

To perfect the technique of his spine operation Albee had developed an electric motor-saw for the removal of the tibial graft. Thanks to this effective instrument, bone-graft surgery became increasingly popular. Mention has already been made of its use in the treatment of fresh and ununited fractures; soon the method was extended to all forms of bone plastics. In 1916 Albee published his first book on *Bone Graft Surgery* detailing the numerous uses to which the bone graft could be put. This clinical application of bone grafting was based on important experimental work which preceded it. In 1912 appeared Macewen's book *The Growth of Bone*. The great Scottish surgeon presented a series of convincing experiments to prove that the periosteum acted simply as a limiting membrane and that bone growth occurred through the functional activity of the osteoblast. Albee published an experimental study of bone growth in 1913. Gallie in 1914 wrote on the "History of a Bone Graft." His contention was that all bone cells of the graft die and that the graft acts simply as a scaffolding. Mayer and Wehner in 1914 published their paper on "Experimental Study of Osteogenesis." These authors came to a conclusion opposed to that of Macewen. They excluded the periosteal activity by applying a small metal or glass cap to the surface of a rabbit's tibia and found

that under those conditions there was no evidence of activity of the osteoblasts: that on the contrary wherever the periosteum regenerated, abundant bone growth occurred. These authors were also able to show that in transplants of young spongy bone not all of the bone cells had the appearance of being dead; a number of them showed definite evidences of cell division, indicating their viability.

The experimental method of investigation became more important during this transition period and was applied by many orthopaedic surgeons to aid in the solution of practical problems of treatment. In 1906 Silver of Pittsburg studied the extent of necrosis caused by tendon suture. In 1907 Osgood, using a clever spring-balance device, studied the comparative strength of the foot muscles. The next year Legg (1908) wrote his thesis for admission to the American Orthopaedic Association on experimental study of atrophy in joint disease. Nathan in 1909 studied the effects of injecting staphylococci into the joints of rabbits. Meisenbach tried to stimulate bone-growth by the injection of formalin or alcohol into the region of the epiphysis. Stern (1910) studied the circulation of club feet by injection of the vessels. Thomas (1914) ankylosed the spine of kittens in order to observe whether this caused any retardation of growth. Erlacher of Graz (1915) reported to the Association his experiments on the direct neurotization of paralyzed muscles. Lovett (1916) elaborated on the spring-balance test begun by Osgood so as to check the relative strength of normal and paralyzed muscles. Haas of San Francisco (1917) made a fascinating study of the relationship of blood supply to the longitudinal growth of bones and was able to show that the nutrient artery was of no significance, whereas the vessels in the region of the epiphysis were of the greatest importance. Steindler (1917) studied the nutrition and vitality of tendons after transplantation.

Largely because of these experimental studies, technical advances occurred in almost every field of orthopaedic surgery. Methods of improving the residual deformities of poliomyelitis engaged the attention of many orthopaedic surgeons. Lange in 1910 as the guest of honor of the American Orthopaedic Association gave an exhaustive paper on the subject. His particular contribution was the utilization of silk to prolong tendons so as to insert them directly into bone. The silk was impregnated with paraffin and sterilized with sublimate of mercury. By means of these silk tendons he claimed satisfactory correction of deformity in many hundreds of cases. Bartow of Buffalo used silk to form supporting ligaments of the joints: with Plummer in 1911 he published his first article. In 1913 and 1916 there were additional papers in the last of which operations on 152 joints were reported. G. G. Davis of Philadelphia expressed himself as strongly opposed to the use of silk ligaments which gave, in his opinion, only temporary improvement. Of more permanent benefit were the astragalectomy operation of Whitman for the correction of calcaneus deformity first published in 1901, and the horizontal transverse section for cavus deformity published by G. G. Davis in 1913. The correction of calcaneus by the two-stage operation of Robert Jones (1907) gave excellent permanent results. In 1916 appeared three papers by Mayer on the physiological method of tendon transplantation. They were the outgrowth of experimental and clinical work done with Biesalski of Berlin; in the method described each step of the operation was made to conform with the known facts of tendon anatomy and physiology. They furnished the basis for the subsequent brilliant advances in tendon surgery by Dr Sterling Bunnell. Gallie (1922), instead of using silk ligaments to fix joints, performed a tenodesis operation. He was able in 1916 to report 90 per cent of successes in 150 cases.

In the field of nerve surgery attempts were made to employ the direct neurotization method which Erlacher had demonstrated as effective in animals. Steindler (1915) found that there was a slight regeneration in clinical cases but not enough to be of clinical significance. In the field of cerebral palsy, Allison and Schwab in 1910 injected alcohol into the nerves of overactive muscles so as to produce temporary paralysis. With a similar idea in mind Stoffel of Mannheim reported in 1913 his method of severing portions of the nerves of spastic muscles. His technique involved an accurate knowledge of the internal architecture of the nerves.

Still another approach to the problem was that of Foerster of Breslau; utilizing laminectomy as an approach he severed some of the posterior nerve roots of the spastic lower extremities so as to interrupt the reflex arc. Hunkin (1913) reported his results in eighteen operations by this method; his results were fairly good.

Scoliosis during this period witnessed two vigorous attacks—the first in 1906 and 1907 by Henry O. Feiss of Cleveland who published an exhaustive series of papers dealing with the etiology of the condition, the second by Dr E. G. Abbott of Portland, Maine, in August 1913. Abbott placed his patients in a hammock in a flexed position and instituted rotational and lateral compression to force the vertebrae to return to the normal position through the same path by which they had progressed to deformity. His results aroused great interest not only in America where they furnished the subject for a symposium, but also abroad. In 1913 he demonstrated his method in Berlin before the Deutsche Orthopädische Gesellschaft, and also in France. The enthusiastic reception which first greeted his work was somewhat tempered by the reports (1914, 1915, 1916) of a committee on scoliosis (Freiberg, Silver, Osgood) appointed by the American Orthopaedic Association; they concluded that though some cases actually showed correction the force employed was so great as to be dangerous. Abbott replied to the Committee in five papers (1917) which presented a mass of clinical material substantiating his claim that structural scoliosis could be completely corrected. Why has the method fallen into disrepute ? Probably because, despite the correction, patients developed other unsightly deformities of the ribs and pressure wounds of such a degree as to make the aesthetic end-result distasteful to them.

The contributions of Dr Michael Hoke of Atlanta deserve special recognition. In 1903 he essayed the difficult feat of correcting a severe scoliosis by extensive rib resections on both the convex and concave sides. His patient survived the two operations and was apparently benefited by them. Of more significance was his paper in 1911 on the pathology and operative treatment of severe recurrent club feet. This masterly presentation showed Hoke to be an authority on the anatomy and function of the foot. His operative methods were precise, ingenious and so effective that practically normal function was secured. This study of club feet led to his development of a special operation to reshape and stabilize paralysed feet, by combining subtalar arthrodesis with temporary resection of the head of the talus and replacement in such a position as to balance the foot. Although not published in the Journal until 1921, the operation was devised at a much earlier date and is therefore included in the period with which we are now dealing.

Frank Ober also made an important contribution to the operative correction of club feet by his procedure, reported in 1916, in which he divided the deltoid ligament and any other restraining bands on the medial side of the foot.

The idea of lengthening short legs by osteotomy and traction was first advanced by Codivilla in 1903. His idea was elaborated in 1916 by R. T. Taylor who combined the lengthening of the short leg with a shortening of the long leg. This idea was later to lead to important developments.

In 1917 appeared an article of particular significance by Smith-Petersen on a new "supra-articular subperiosteal approach to the hip joint." This was the first of a series of important contributions by an orthopaedic surgeon who has always based his work on most precise anatomical knowledge.

While these practical improvements in operative therapy were being made, pathological knowledge was advancing rapidly. The value of the Roentgen ray as a means of study and diagnosis began to be more generally appreciated, and Osgood in 1903 wrote: "As in the evolution of any new discovery applicable to medicine, the opinion of the profession in regard to the value of the Roentgen rays has passed through certain stages. These may be described as the stage of enthusiasm, the stage of disappointment, and finally the stage in which the true value is admitted and the limitations recognized." He then proceeded to point out the

limitations and the positive value of the X-rays. Blanchard (1906) made a contribution to the pathology of rickets by X-ray studies, Painter and Rogers in the next year to the diagnosis of neoplasms whose presence " might give rise to confusion in the minds of orthopaedists." R. T. Taylor pointed out its value in the detection of tuberculous coxitis (1903). In 1915 Percy W. Roberts of New York described nine cases of " juxta-articular sarcoma." That some of those cases eventually proved to be myeloma, not sarcoma, does not detract from the historical value of the paper; by post-mortem studies and the examination of museum material much was learnt. Allison (1905) wrote a most illuminating account of the pathology of congenital hip dislocation as the result of the post-mortem dissection of a seven-year-old Navajo Indian girl who died four months after reduction. Brackett (1910) added greatly to our knowledge of the pathology of spinal tuberculosis by a study of the specimens in the Warren Museum of the Harvard Medical School. Elliott (Montefiore Hospital, New York) performed autopsies in five cases of rigid spine (Marie-Strumpell) and published his observations (1905). Mayer (1913) described a specimen of congenital anterior subluxation of the tibia on the femur, and suggested an operative method for curing the condition. Ely (1913) described the pathological changes in two cases of tabetic arthropathy which came to post-mortem examination. By combining clinical observation with X-ray study and occasional observations at the operating table, numerous advances were made. In January 1903 Osgood published a thorough study—anatomical, clinical and pathological—of the adolescent tibial tubercle; and in October of the same year Schlatter published a similar paper. Freiberg (1905) wrote on coxa vara adolescentium in its relation to arthritis deformans, Napier (1905) on two cases of spondylolisthesis, G. G. Davis (1905) on multiple exostoses, Blodgett on congenital dislocation of the head of the radius, Geist (1907) on chondrodystrophy, Yaegar on exostoses of the os calcis which he considered gonorrheal in origin, Painter and Clark (1908) on myositis ossificans, Horwitz (1909) on adolescent rickets, Freiberg (1910) on osteochondritis dissecans, S. Fosdick Jones (1911) on Madelung's deformity, Dunlop (1911) on the adolescent tibial tubercle, Silver (1911) on benign cysts of bones, Coon (1911) on dyschondroplasia, Hammond (1911) on brittle bones, Gaenslen (1915) on Paget's disease, Allison and Moody (1915) on osteochondritis deformans juvenilis which H. L. Taylor characterized in the same year as " Quiet Hip Disease," now usually termed Legg-Calvé-Perthes disease.

Of special note is the study of Sprengel's deformity published by Alexander E. Horwitz in 1908. Carried on under the supervision of Bradford, Lovett and Brackett, it illustrates what can be learned by combining the historical viewpoint with clinical and pathological study. Aside from a few improvements in operative technique little has been added to Horwitz's paper during the past forty-two years. Another pathological-clinical paper of great importance was Sever's (1916) on obstetrical paralysis. He demonstrated the site of the pathological lesion, classified the paralysis, disproved the theory of T. Turner Thomas that the essential pathology was in the shoulder, and worked out an excellent method of operative correction. Fisher (1916) published a paper on torticollis, Brackett and Hall (1917) on osteochondritis dissecans, Henderson (1917) on osteochondromatosis of the knee, Freiberg (1914) on infraction of the second and third metatarsals, Honeiz (1917) on bone changes of leprosy, Barrie (1918) on haemorrhagic osteomyelitis and bone sarcoma.

Another method of study has already been alluded to under the topic of backache—the anatomical approach applied to clinical problems. Goldthwait has been the most brilliant exponent of this method. He applied it not only to the lumbo-sacral and sacro-iliac regions, but also to the shoulder. His paper in May 1909 on " An Anatomic and Mechanical Study of the Shoulder Joint, explaining many of the cases of painful shoulder, many of the recurrent dislocations and many of the cases of brachial neuralgias or neuritis" should be read by every orthopaedic student, not because all of Goldthwait's conclusions have stood the test of time, but because it is such a beautiful application of the scientific methods of accurate observation, deduction and induction. Goldthwait extended these studies to " relation of posture to

human efficiency " (1909) and to the " influence of poise upon the support and function of the viscera." He considered good posture as essential to good health. To support his thesis he not only studied anatomical sections to illustrate the effects of visceroptosis but also turned " to the direct study of the human family " as portrayed in sculpture; from the period of the early Greeks down to St. Gaudens's figure of Lincoln he found "the chest high, the shoulders erect, the trunk so in balance that no group of muscles or part is strained, but action with the minimum of waste is possible, while the visceral support and function is maintained with the least effort." Swaim continued in the footsteps of his teacher Goldthwait and elaborated the theme in his paper " The Mechanically Unfit " (1915).

In the field of preventive medicine, Goldthwait (1916) maintained that " the orthopaedist had a much larger place than is commonly held." He wrote: " The time to stop the functionally weak back is in childhood by teaching the child how to use its spine. The time to prevent pulmonary disease is in childhood through training so that the body will be so developed that the lungs can be used rightly and gain the strength with which to throw off disease. The time to correct visceroptosis is in childhood, when the body can be so trained that the postural habits of weakness which lead to the harmful displacements cannot develop." Previous to this paper, the American Posture League had been formed in April 1914 with Miss Jessie H. Bancroft, assistant director of physical training in the New York City Board of Education, as president. Its activities were the direct result of the teaching of orthopaedic surgeons, beginning with Bradford and Reginald Sayre; the latter in his presidential address (1904) urged that the orthopaedic surgeon " teach our teachers what kind of desks the pupils should use in our schools. He must also impress on our public educators that there is very little use in developing the mind if it is done at the expense of so much wear and tear of the nervous system that the body which is to be controlled by this mind becomes a physical wreck." The Posture League hoped " by systematic education to establish a demand for healthful standards in what may be termed posture engineering." It assisted " with expert advice the engineers of the Brooklyn Rapid Transit Company, the seats of whose new subway cars are being constructed in accordance with the League's specifications." It was " in touch with several large organizations of workers engaged in the standing occupations—such as motormen and shop-girls—and proposes issuing official bulletins for their benefit illustrating the correct standing postures both for work and rest."

In other ways too one is conscious of a growing sense of responsibility of the orthopaedic surgeon to the community. E. G. Brackett (1905) urged that young orthopaedic surgeons should settle in communities where they were needed. Charlton Wallace made a special study in 1907 of the effects of imperfect hygiene on the production of bone tuberculosis, and urged that steps be taken to improve conditions in the tenements. Henry L. Taylor in his presidential address (1908) urged the importance of organizing the home, so as to " make it an integral part of the orthopaedic service. . . . The school should also be brought into helpful relation with the home, hospital and clinic. . . . Many children unable to attend public schools may advantageously attend special schools or classes for crippled children, or special classes in the hospital, or may receive instruction at their homes." Thus began the special classes for handicapped children, which are now a feature of the public school systems of most of our cities.

More and more what Dr Albert Freiberg (1937) has characterised as " The Social Point of View " has played an important part in orthopaedic surgery. " From the time when the identity of the orthopaedic surgeon became recognised, the care and the rehabilitation of the cripple has been his particular province. This is true of both the child and the adult cripple. . . . In every country which has developed facilities for the aid of indigent cripples, the orthopaedic surgeon will be found in the background, first winning respect by excellent professional accomplishment." The state care of crippled children was begun in the same year as the founding of the American Orthopaedic Association, and by one of its members, Arthur J. Gillette of St Paul. He persuaded the legislature of the State of Minnesota to

establish a hospital for crippled children: this was actually opened in 1897. His example, however praiseworthy, was not followed with the rapidity which it deserved; there were not many orthopaedic surgeons so persuasive as Arthur Gillette. Twelve years later (1909) in an editorial in the Journal he wrote of the sad plight of orthopaedic patients who in a large city with extensive hospital facilities had to return to their homes untreated because there were no vacancies. He continued: " After fifteen years of observation . . . it is quite difficult for one to refrain from making a simple and impassioned argument setting forth the necessity for state care of the crippled and deformed. When one reads the various letters of inquiry [to the Minnesota State Hospital for Crippled and Deformed Children] one cannot but wonder what becomes of these children living in states or cities where no institution whatever exists for their care and treatment; yet there are in the United States to-day forty-seven states and territories that have no provision for this class of unfortunates." Despite the slow response of state legislatures, private charity did something to make good the deficiency. In 1911 Douglas McMurtrie, a young man who ran a printing establishment in New York, wrote the leading article for the May issue of the Journal; it was entitled " The Care of Crippled Children in the United States." He, too, concluded his paper with a plea for state support. " From a national standpoint the situation is most unsatisfactory, all the institutions being grouped around four or five cities. The gravest defect is that immense sections, notably the West and South, are without any provision whatever."

H. Winnett Orr of Lincoln, Nebraska (1911), also favoured state support, and cited the example of the Nebraska Orthopaedic Hospital, whose increasing usefulness during the five years of its existence had been met by " increasing appropriations by the legislature." The argument between those favoring state and those favoring private care is still being hotly contested, but the " grave defect " emphasized by Gillette and McMurtrie has gradually been eliminated thanks to the constant hammering of social-minded orthopaedic surgeons and public-spirited laymen.

A most significant advance in the " social point of view " was the development of the so-called " compensation acts." These were state legislative enactments to assure an injured workman adequate medical treatment, partial financial reimbursement for loss of salary and, in case of permanent injury, financial compensation for loss of earning power. They have been passed in all the states except Mississippi. These laws are of such importance to orthopaedic surgery that, at the author's request, Dr Michael Burman, associate orthopaedic surgeon of the Hospital for Joint diseases, has written the following summary of compensation law and practice in the United States. (This carries the reader through the transition period. 1902–19, down to the present time.)

Compensation Law and Practice in the United States

The passage of such laws was protested by certain groups as an invasion of the property rights of the employer and hence contrary to the letter and spirit of the Fourteenth Amendment of the Constitution of the United States. Both the Maryland law of 1902 and the Montana law of 1909 were declared unconstitutional. The original compensation act of New York of 1910 was likewise declared unconstitutional (Ives *vs.* So. Buffalo Ry. Co., 201 N.Y. 271), a legal hurdle surmounted by the passage of an amendment to the State Constitution in 1913. In 1917 The United States Supreme Court passed favorably on the constitutionality of the legislation. Two weeks after this decision Idaho and Utah passed compulsory compensation laws.

The essence of all compensation law is the assumption of liability on the part of the employer except in the unusual circumstances of wilful disobedience of rules of safety or drunkenness on the job. The definition of " injury " is usually made sufficiently broad so that the injury need not be acute. Reasonable notice of the accident must be given to a responsible officer of the employer. Hearings are held before an official of the commission or body administering the law. The hearings are informal with minimal but reasonable observance of the rules of evidence. The workman may be represented by a lawyer or a licensed claims representative. A decision is made and, if compensability is established, a money award given which, even in the event of total disability,

is less than the workman's wages. This sum does not exceed $32.00 a week in New York. In Alaska and in six states, the laws are administered by courts.

The right of the workman to choose his own doctor is limited in most states. Medical care is usually given by a physician of the employer's choosing or by the carrier insuring the employer.

The logical extension of compensation insurance is disability insurance. New York, following the example of Rhode Island, made such a law effective on July 1, 1950. A workman, ill of a malady not associated with his work, receives a maximum of $26.00 a week for thirteen weeks. The employee pays thirty cents a week, the employer a similar sum for each of his employees.

The Federal Government has several compensation laws. " Compensation is compulsory for all or some private employments . . . in the District of Columbia and compulsory for all or some public employments . . . in the District " (Koontz). The Federal Employers' Liability Act gives to railroad employees the right of action for injuries sustained by negligence of the railway carrier. The Longshoremen's and Harbor Workers' Compensation Act covers the limited category of employees injured in the navigable waters of the United States, including any dry dock. The Jones Act (Merchant Marine Act of 1920) does the same for seamen on both land and sea and regardless of the nature of the errand taking him ashore.

This brief review can hardly hope to encompass all the details of the various compensation laws.

In the conduct of the hospitals, the " social point of view " invaded the orthopaedic clinic and transformed the patients from mere numbers unto living beings whose social needs required attention just as much as their crippled bodies. Dr Harry Low in 1914 reported his study of the orthopaedic out-patient clinic of the Massachusetts General Hospital in which he credited the social service department " for helping us in many ways in carrying out the treatment." A few years later (1918) Miss Edith Baker, head of the social Service Department spoke for herself. She wrote: " We are all familiar with the advice given to tuberculous patients, ' good food, rest, fresh air and sunshine,' but these are not commodities which can be delivered like drugs. We may order them, but they do not get there unless personally conducted all the way . . . Through frequent home visits these patients have been encouraged to persevere in the treatment (heliotherapy) and some very good results have been obtained." Dr E. G. Brackett in commenting on this report attested to the great value of the Social Service Department. He said it filled a particular need and by way of making his point told about the old darky who when advised by his doctor to " take this medicine after each meal," replied, " Yes, but I would like to know where the meal is coming from." Dr J. Archer O'Reilly of St Louis told of the successful work of the social service department of Washington University which organized a volunteer system of transportation. This method has since been developed by the Red Cross and by organizations for the care of crippled children.

No one has phrased the peculiar responsibility of the orthopaedic surgeon to his patient more vigorously than G. G. Davis in his presidential address of 1914. " It is not fair, it is not just," he said, " that we as orthopaedic surgeons should confine our work and efforts to solely the medical care of our patients: we can do more and we should do more. . . . We are not solely the medical attendants of these cripples but also to a certain extent their guardians. We are the ones who, better even than the parents, can decide to what extent training can go hand-in-hand with treatment."

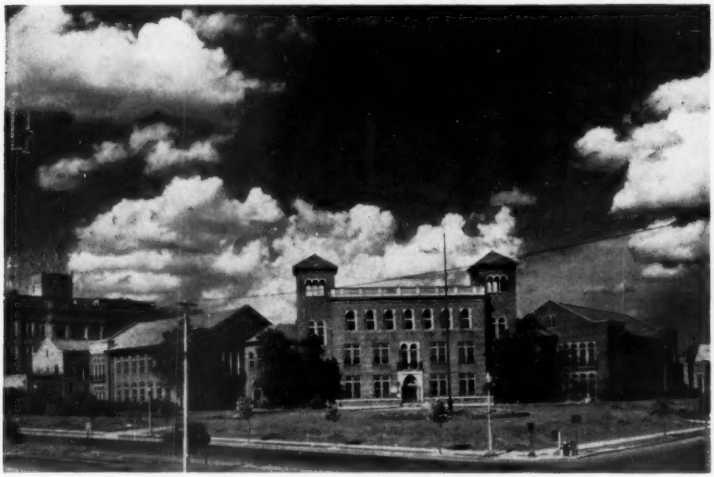
In this same year Dr Michael Hoke of Atlanta began a series of conferences with the officials of the Order of the Mystic Shrine of the Free and Independent Order of Masons (the " Shriners ") which resulted in a vote at the Portland, Oregon, meeting of 1920 to contribute to the support of hospitals for crippled children. The first " Shriners' Hospital " was opened at Shreveport, Louisiana, in 1922 and has been followed by others in San Francisco, Chicago, Springfield (Mass.), Minneapolis, Portland (Oregon), Philadelphia, Salt Lake City, Spokane, Greenville (South Carolina), Honolulu and Montreal.

Lay organizations for the care of crippled children developed: in New York City the Association for the Aid of Crippled Children, and in Elyria, Ohio, the Ohio Society for Crippled Children, later called The International Society for Crippled Children. Founded by Edgar Allen, the Society " seeks to co-ordinate the various social, nursing and medical agencies

The original Children's Hospital building, Rutland Street, Boston, Massachusetts—built in 1869 to accommodate twenty patients. Here Dr Edward Bradford became chief of the Orthopaedic Service in 1878, and here under him served Drs Robert Lovett, Elliot G. Brackett, Joel Goldthwait, Robert Osgood, Arthur Legg, James Sever and many other distinguished orthopedic surgeons; from here emanated most of the 105 articles credited to Bradford during the years 1887–1902; here he taught as the first John Ball and Buckminster Brown Professor of Orthopedic Surgery of the Harvard Medical School. Retiring in 1912 he was succeeded by Dr Robert Lovett, who continued to be as productive as his great predecessor. In 1914 the first summer course in physical therapy was given here under the direction of Dr James Sever.

The Children's Hospital of Boston to-day—a general hospital for 385 patients. The Bader building—including a therapeutic pool, laboratory and isolation building—was opened in 1931; other buildings have since been added. Here the clinics of the Harvard Infantile Paralysis Commission function, many clinical and research problems are investigated, and graduate as well as undergraduate teaching is in full swing. Under the present Chief of Staff, Dr William T. Green, appointed in 1946, the service was reorganised, and affiliation resumed with the Massachusetts General Hospital in the resident-training program as well as with the Peter Bent Brigham Hospital.

The Children's Hospital of the University of Texas Medical College, Galveston. Erected in 1915 with funds raised by the Texas Anti-tuberculosis Association, half of its fifty beds were reserved for cases of tuberculosis. Later, this provision was set aside and all types of crippled children admitted. It was the first hospital in the State devoted to the orthopaedic care of children. In 1923 the Texas Scottish Rite erected a second hospital at Dallas; there are to-day similar hospitals at Houston, Waco, Fort Worth, Corpus Christi and other cities—a development typical of all the States; the late Douglas McMurtrie could no longer write as he did in 1912: " From a national standpoint the situation [with regard to crippled children's hospitals] is most unsatisfactory . . . The gravest defect is that immense sections, notably the West and South, are without any provision whatever."



The Shriners' Hospital for Crippled Children, St Louis, Missouri. Opened in 1924, it is characteristic of the buildings erected by " the Shriners " after Dr Michael Hoke had enlisted their support in the care of crippled children (page 477). Here Dr Albert Key and Dr Le Roy Abbott did their early work with Dr Crego as their resident. To-day Drs McCarroll and Crego, the heads of the Service, are making outstanding contributions to the treatment of congenital hip dislocation, infantile paralysis, cerebral palsy and many other orthopaedic conditions.

concerned in the problem of the crippled child, and attempts further by subsidizing the publication of books and magazines to awaken the consciousness of the lay communities to his needs." (Edgar Bick 1948).

Meanwhile, amid the ceaseless production of new techniques, new investigations, new knowledge, new goals, new lines of thought, it was but natural that orthopaedic surgeons should decide to come together more frequently than at the yearly convocation of the American Orthopaedic Association. They had much to talk about: exchange of views was bound to add to the fund of knowledge. Many orthopaedic clubs and societies were started. Probably the oldest of them was the Boston Orthopaedic Club (1896); in 1902 the Inter-urban Orthopaedic Club was founded, and the orthopaedic section of the New York Academy of Medicine; in 1910 the Chicago Orthopaedic Society. When Dr Freiberg was president of the Association (1911) he devoted part of his address to the question whether the Association " has responded to all the demands which may rightfully be made upon it." He continued: " At the great convocation of physicians and surgeons which takes place annually in the spring [the meetings of the American Medical Association] there are represented adequately all the specialities of our profession save one: orthopaedic surgery. It is for you to say whether this is as it should be." Thanks to him, the Orthopaedic Section of the American Medical Association was organized the following year. In 1912 the Central States Orthopaedic Club was created under the aegis of Dr John Porter of Chicago; two years later the Western States Orthopaedic Club with Dr Harry Sherman of San Francisco as its president, and in the same year the Philadelphia Orthopaedic Club. Since that time each city with a nucleus of orthopaedic surgeons has organized its orthopaedic " club "; many inter-urban groups, such as the " Robert Jones," have been formed; and at the State Medical Society meetings there are sections devoted to orthopaedic surgery. These meetings have helped to educate by exposition, demonstration and discussion; they have encouraged men to develop new ideas.

In the medical schools orthopaedic surgery made slow but consistent progress. The Association appointed a committee in 1909 to investigate undergraduate instruction in orthopaedic surgery. The committee reported in 1910 that it had received answers to its inquiries from 110 out of 126 colleges; in forty-one, orthopaedic surgery was taught as a separate branch (Group I); in fifty-one, it was combined with general surgery (Group II); the total number of hours allotted to orthopaedic surgery averaged sixty-four in Group I and forty-seven in Group II; there were thirty-five professors in Group I and thirteen in Group II. The committee recommended that orthopaedic surgery be taught as a separate and distinct department in charge of a professor, that a minimum of sixty hours be allotted to the subject, and that instruction be partly didactic, partly clinical. Charles F. Painter (1913) in his paper on the development of orthopaedic teaching in America also favored the didactic lecture, to be followed by a " quiz " and clinical demonstrations. He concluded: " To the teacher and investigator there is no more fruitful field than is offered by this subject."

So the stage was set for an event which, tragic though it was for the world at large, brought recognition, honor and a wealth of new experience to our speciality—the first world war. In the March 1917 issue of the Journal appeared a letter from Dr Joel E. Goldthwait telling of the appointment of committees by the American Orthopaedic Association and the Orthopaedic Section of the American Medical Association to consider " the question of the orthopaedic preparedness of the nation. . . . In this country we need, as in England, a large number of hospitals . . . to which the patients can be sent after the immediate care at the Front has been given, and where they can be kept long enough for the needed reconstruction work to be completed. . . . Such work, of course, involves also the teaching of trades and occupations to those who may be crippled, the lines followed to be similar to those which have been worked out so admirably in England under the guidance of Colonel Robert Jones." In the May 1917 issue appeared an editorial entitled " The Opportunity." It told of the willingness of orthopaedic surgeons to serve and their prompt response to the inquiries of

the "Committees on Preparedness." The Journal recommended: 1) the appointment of a director of orthopaedic general hospitals; 2) the immediate organization and equipment of two or more such hospitals; and 3) the conservation by the Government of the orthopaedic resources. It pointed out that " the speciality is a small one. In the event of hard fighting the demand, we believe, will be a large one. . . . England has already been seeking our help. We may need every available orthopaedic surgeon for the work he is specially fitted to do. . . . The comfortable transport of the wounded would receive his attention, but probably his first important service may be rendered at a base hospital well back of the line. More than half the injuries of modern warfare are lesions of the bones and joints; some observers have said 75 per cent. In civil life when these cases present themselves, the general surgeon turns to the orthopaedic surgeon—in the terrible wounds of war he should also be available."

Dr David Silver, president of the Association, sent a letter urging attendance at the annual meeting, concluding with the words " Your country needs you."

In the June issue of the Journal an editorial reported that a cable had gone out for twenty trained orthopaedic men to go to England to work under the direction of Robert Jones. Within twenty days, on April 28, twenty-one men had sailed on their way for duty. Dr Joel Goldthwait, the leader of this medical group, has been gracious enough to contribute a brief account of his recollections of these war years. He writes:

> Until the first world war, orthopaedic surgery in Great Britain was not a very important speciality, but the large number of disabled veterans presented such a problem for rehabilitation that Sir Robert Jones was turned to in the hope of improving conditions. His results were so striking that the importance of this branch of the medical and surgical profession began to be appreciated and assistance was asked from the United States. At that same time in the United States, orthopaedic surgery was recognized, the Orthopaedic Association was active, but the number of men carefully trained in that profession was not large and the general surgical profession was not friendly to the orthopaedic activities. In Great Britain also the general surgical group was not too co-operative. The need for help was so great that when the United States declared war (April 7, 1917) at once a cablegram came from Great Britain asking for six base hospitals to aid the British and twenty orthopaedic surgeons to serve with Sir Robert Jones. This at once established the fact that the British Government recognized orthopaedic surgery as of importance. In this country the position Great Britain had taken was recognized and immediately it was decided to send the assistance requested.
>
> As chairman of a special committee that had been working for over a year listing the orthopaedic surgeons that would be available in case of war, a message from Washington came to me the day the cable was received, and the next day a conference was held by me in Washington for the situation. Immediately telegrams were sent to twenty of the younger orthopaedic surgeons asking them to enlist and to arrange for transfer to England to serve under Sir Robert Jones. In one day less than three weeks these twenty men sailed with me for England and were assigned to work with Sir Robert Jones upon arrival at Liverpool.
>
> This recognition of the importance of orthopaedic surgery by the Governments of both Great Britain and the United States established the speciality in a way that almost nothing else could have done. Naturally, much of the work was in the field of traumatic surgery with which few of the orthopaedic men had had much experience, but the principle underlying orthopaedic surgery—improving the function of a damaged part as much as possible—applied directly to the war casualties. Both the British Government and our Government recognized the need of these trained specialists and insisted that none of them be removed from their orthopaedic assignments.
>
> After studying the work in England and France, and planning the requirements of our own Army, I returned to the United States and spent nearly two months in

Washington helping to perfect the organization of the Orthopaedic Department of the Army.

As the result of this, in October I sailed again for England accompanied by forty-five officers, many of whom had had considerable experience in orthopaedic surgery, the others hurriedly trained in the fundamentals of orthopaedic surgery, and with them, twelve orthopaedically trained nurses and three officers expected to develop the occupational therapy shops. This latter feature had been very much developed in England where "curative workshops" were part of each hospital center. All these doctors and nurses were at first assigned to the British under the direction of Sir Robert Jones. Later, other groups were sent over from the United States and distributed among the hospitals as needed.

As our own organization developed, the officers that had been serving in the British Hospitals under Sir Robert Jones's direction were gradually withdrawn for assignment in the American Hospitals and other officers were sent to fill the gaps.

Splints and surgical supplies—Almost at once, as the military problem was studied, it was obvious that it was necessary for our Service to have proper apparatus for taking care of the wounded, and that no such apparatus was being sent over either with the Hospital Groups or with the Combat Divisions. It was also recognized that proper splints should be applied to the wounded man before he was taken from the ground to be placed on the stretcher. Recognizing the complete lack of such equipment and the necessity of manufacturing it in France, where there was only a meagre supply of raw materials and of labor, it was obvious that the utmost simplicity and economy had to be observed.

By eliminating all non-essentials it was shown that with seven types of splint practically all the needs of the wounded man could be met. Every stretcher carried with it a Thomas' splint for the leg and an arm splint for the arm and shoulder. The system that was followed when the wounded men were placed in the ambulance was: the ambulance delivered to the stretcher-bearers a stretcher equipped with two splints. When the wounded man was delivered at the dressing station the ambulance received another stretcher and another set of splints. This was continued all the way back. By this system the wounded were handled with a minimal degree of pain; and the orthopaedic splinting started on the battlefield was continued until the patient was on his way home.

Since it was necessary for the wounded to be moved from one hospital to another in order to accommodate the new cases that were coming in at the Front, a wounded man had to be under the care of several different surgeons before he reached the Base ports. The unit splint, however, helped to give continuity to the treatment and the results were, in the main, satisfactory.

As the work went on, Dr John Finney, the director of general surgery, realizing that his training as an abdominal surgeon did not qualify him for the treatment of this type of injury, held a conference with me which resulted in an order by the Chief Surgeon of the A.E.F., transferring the responsibility of these cases to the Orthopaedic Department. This led to the assignment of orthopaedic consultants in all of the large battle or hospital areas and while the work naturally had to be performed by the general surgeons, the general handling and the functional restoration were directed by the orthopaedic consultants.

Because of the rapid increase of battle casualties, the Engineering Department was unable to build enough hospitals. As a consequence, in the latter part of the summer General Ireland, the Chief Surgeon, summoned me to his office and stated that it was necessary to have some of the so-called "non-transportable" cases, chiefly the bad femur injuries, sent to the United States. "If not," said the General, "the wounded will have to lie on the battlefield."

It therefore became necessary to reorganize the method of handling severe bone injuries. One week later I personally spent the night on a hospital train carrying 500 of

these cases to the port of Brest. Each man had been carefully splinted and carried a tag telling how the case should be handled. Since the harbor of Brest had no dockage facilities for large transports, it was necessary to transfer the patients from the hospital train to lighters which took them to transports anchored three miles from shore. That same afternoon the transports sailed for home. Since none of the cases suffered from this method of transportation it was generally adopted and from then on the wounded were moved as rapidly as possible from France to the United States.

While Dr Goldthwait was busy in England and France, the American Orthopaedic Association met in Washington under the presidency of Dr Silver. The attendance was the largest in the history of the Association. The president pointed out the importance of orthopaedic surgery in war work and reported that three members of the Association had already been appointed to the important Committee on standardization for medical and surgical supplies and equipment. The Journal in the editorial columns published three important papers, the first by Colonel Robert Jones, the second by Dr Gallie, and the third, Dr Goldthwait's report as chairman of the Committee on preparedness. Colonel Jones's paper was a reprint of the introduction to his book *Notes on Military Orthopaedics*. It told about the " curative workshops "—why they had been started and what they were doing. " In the Military Orthopaedic Hospital at Shepherd's Bush alone," he wrote, " out of 800 patients about 500 are employed at some regular work which fosters habits of diligence and self-respect, and converts indolent and often discontented patients into happy men." Gallie wrote " How Canada is Caring for her Crippled Soldiers." He described in some detail the types of war-wounded whom they were treating, the methods employed, and in particular their experience with the amputees. He also wrote of vocational training: "Although the problem was very haltingly dealt with at first, it has now become a national institution." Goldthwait's report included important recommendations on the physical training of the recruit, particularly of his feet, and of the proper types of army shoes. He outlined the organization of the Military Orthopaedic Hospital and told of the medical mission to England. He concluded: " It is quite obvious that the orthopaedic profession is meeting its opportunity, and the recognition of the need of such work by the officials in Washington should be a source of much satisfaction." Orthopaedic surgery in America had at last come into its own. Substantiation is found in the letter of Dr Charles Parker of Chicago (1919) to the editor of the Journal, published in the November issue. It ends with this significant paragraph: " This is truly the era of orthopaedic surgery and the enormous impetus give it by war practice is certain to be reflected in civil practice with results of inestimable value to the multitude of potential cripples constantly repleted from the vast army of citizens engaged in the peaceful pursuits of our normal industrial life."

At the October 1917 meeting of the Boston Orthopaedic Club Dr Brackett, who had been made director of orthopaedics in the Government with the rank of major was the chief speaker. He said in part: " Very early in this war the Department had decided that since a man is taken out of industrial life well and strong and a wage-earner, and is put into service and is there injured, it is the duty of the Government, and therefore of the Army, to consider him as its ward and to replace him in civil life not only repaired to the greatest potential degree through surgical and medical care, but also to put him back into the community so that industrially he is an efficient man." He told of the reorganization of the army medical department into a series of specialities, each to take charge of a particular group of cases. He estimated that the number of orthopaedic beds in France would amount to about 35,000. To take care of this number and to do the work in England and at home, more orthopaedic surgeons were needed. To train men, courses in orthopaedic surgery were to be started in New York and in Boston. In summing up he said: " The men who are to do orthopaedic surgery must have in view one very distinct feature, and that is *to restore function*. That has to be the fundamental thing. Necessarily it is a long stay, weeks and months perhaps, but

this must never be lost sight of—not only restoring the function surgically and medically but undoing the habit of long invalidism."

The meeting of the American Orthopaedic Association in 1918 was devoted almost wholly to military surgery. Dr John L. Porter, the president, told of the work done by the medical department of the Army under Surgeon-General Gorgas, who had expanded the staff from a few hundred to 20,000 in one year, and of the Orthopaedic Department under Dr Brackett (now promoted to Lieutenant-Colonel) whose personnel comprised 626 commissioned officers. "Every training course, base hospital and fort is supplied with at least one competent orthopaedic officer and assistants. And men of experience in the speciality are on duty abroad." There were stimulating papers by Clarence Starr of Toronto, DeForest Willard and James Rugh of Philadelphia, Sydney Cone and William Baer of Baltimore, Edward Rich of Tacoma, William Erving, George Hawley of Bridgeport and many others. Hawley's paper deserves particular comment since it dealt with a revolutionary method of treating bone infections—the Carrel-Dakin technique. He stated that after watching Carrel's work for several months he was convinced that his method represented one of the most important advances in surgery. "For the first time in the writer's experience it has been possible to definitely sterilize suppurating infections of the bones and joints and see them heal without any evidence of pus and without sinus formation. . . . The method is technically difficult and laborious. Each daily dressing is like performing a clean surgical operation at the bedside. . . . Only those who have had the opportunity to study at first hand the principles and have patiently persisted through obstacles and failures can appreciate what Carrel has contributed to surgical science."

Several books of military significance were published. In addition to Robert Jones's *Notes on Military Orthopaedics* the Army published an excellent *Manual of Splints and Appliances* and a *Medical War Manual (No. 4) in Military Orthopaedic Surgery*. Douglas McMurtrie, who had helped to found the Red Cross Institution for Crippled and Disabled Men published *The Evolution of National Systems of Vocational Re-education for Disabled Soldiers and Sailors*. This was issued by the Federal Board for Vocational Education and contained important information on the details of rehabilitation and its history in other countries. Dr Brackett wrote the introduction to a monograph by Mayer on *The Orthopaedic Treatment of Gunshot Injuries*, in which he welcomed a book "that comes to us at a time when it is needed."

Of great significance were two papers: one by King Manuel of Portugal, representing the British Red Cross, on "The Scheme of Curative Workshops in the Orthopaedic Centres of the United Kingdon"; and the other by Sir Robert Jones on "The Problem of the Disabled"—both published during the spring of 1918. The distinguished layman and the great orthopaedic surgeon alike had the same message to deliver: the overwhelming importance of rehabilitation to the economic and moral life of the nation. Those who love beautiful prose should read the concluding paragraphs of Sir Robert Jones's paper. I quote only a few sentences: "Are our memorials to be spiritual or material, living and permanent, dead or cold? For my part I have no hesitation in saying that cold marble or perennial brass has no re-echoing voice to me. My feeling is that the heroic spirit that sent our beloved dead to their end, should be reflected in an equally heroic effort on our part to make and keep the nation efficient."

In America the theme was ably enunciated by Major Robert W. Lovett (1918) who wrote: "The curative workshop represents the most important and the newest feature of the therapeutic stage of reclamation, and it is a natural sequence to bedside occupation. In the curative workshop the brain is kept interested in mechanical results accomplished and the physical improvement comes on apace."

So the war brought recognition to orthopaedic surgery, and to the orthopaedic surgeon fell that most important phase of treatment: restoration of function and the return of the soldier to normal living.

Dr Buckminster Brown (1819–1891)

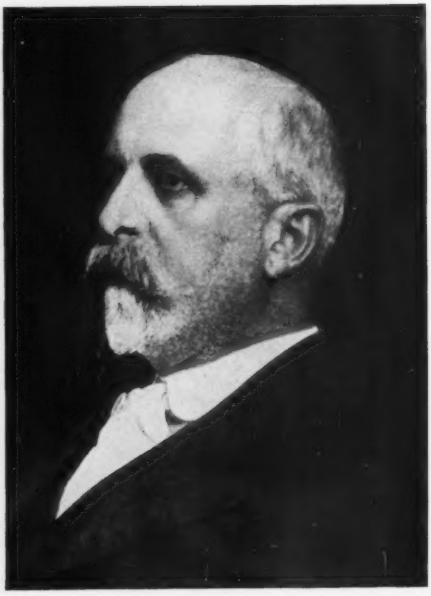
Son of the distinguished Dr John Ball Brown, one of Boston's earliest orthopaedic surgeons, and grandson of Dr John Warren, the first Professor of Surgery at Harvard Medical School, he was one of the " founding fathers " who belonged to the older generation. After studying abroad in 1845 and 1846—in London under John Little, in Paris under Guérin and Bouvier, in Germany under Strohmeyer—he began practice in Boston and soon devoted himself exclusively to orthopaedic surgery. He was placed in charge of the first ward in New England devoted to orthopaedic surgery at the Samaritan Hospital in 1861. Bradford credits him as being the first American orthopaedic surgeon to cure a double congenital hip dislocation. It was said of him that he " was an orthopaedist in the best and broadest sense of the word, using all means—operative, mechanical and medicinal. His mechanical ability was great and his surgical dexterity was equally remarkable." At his death he left a large sum of money to Harvard University to endow an orthopaedic professorship, which is still in existence.

Dr Charles Fayette Taylor (1827–1899)

One of the founders of the American Medical Association, and frequently termed the father of American orthopaedic surgery. He organized the New York Orthopaedic Dispensary in 1866 to which the hospital was added in 1873. He was the first to devise a brace which gave adequate support to patients with Pott's disease. This he termed " the spinal assistant." At his death in 1899 Dr E. H. Bradford wrote of him: " he was largely influenced to turn his attention to the branch in which he distinguished himself by a humanitarian desire to attempt a cure in a child suffering from what was regarded at this time as an incurable disease—caries of the spine. To this effort he enlisted himself with all the energy and ingenuity of a fertile and persistent mind, regarding the supposed impossibility of successful treatment as a challenge for strenuous endeavor."

Dr Lewis A. Sayre (1820–1900)

Appointed visiting surgeon to Bellevue Hospital in 1853, he held the first chair of orthopaedic surgery to be established in the United States (1861) at Bellevue Hospital Medical School. He was an impressive teacher, an eminent author and an intrepid surgeon, famed as the first to perform an excision of the hip joint (1854). He was elected to membership in the American Orthopaedic Association in 1889, an honor conferred on his distinguished son, Reginald H. Sayre, two years before. Though never elected president of the orthopaedic association, he was president of the American Medical Association (1880). He showed medical as well as surgical talent during his six years of service as resident physician of the City of New York. "He advocated compulsory vaccination, intelligent disposal of sewage, sanitary inspection of tenement houses, and quarantine for cholera." (From Cleveland and Winant: *Instructional Courses of American Academy Orthopaedic Surgery at Fourteenth Annual Assembly*, January 1947.)



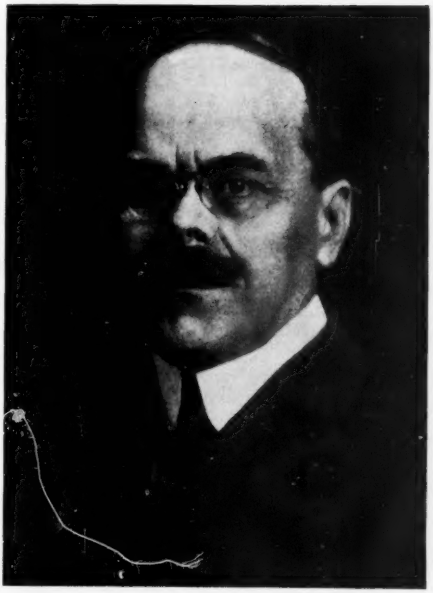
Dr Virgil P. Gibney (1847–1927)

First president of the American Orthopaedic Association, re-elected in 1912—an honor accorded no other orthopaedic surgeon. Surgeon-in-chief to the Hospital for Ruptured and Crippled from 1887 to 1924, professor of orthopaedic surgery at the College of Physicians and Surgeons, of Columbia University. Though himself inadequately trained as a surgeon, he was a man of vision and sensed the direction which the speciality was bound to take. Stating that orthopaedic surgery was "as yet in its infancy," he predicted (1891) that orthopaedic surgery would include the treatment of fractures, particularly "how to relieve old intra-capsular fractures of the neck of the femur" and "how to correct the deformities that follow badly united fractures and poorly replaced dislocations."

Dr Newton M. Shaffer (1846–1928)

Surgeon-in-chief of the New York Orthopaedic Dispensary and Hospital from 1877 to 1898. With Virgil Gibney he called together thirteen other orthopaedic surgeons in 1887 who voted to organize the American Orthopaedic Association, and in 1888 he became its second president. Untrained in surgery, he showed mechanical ingenuity and considerable administrative ability. He, together with A. B. Judson, bitterly opposed the growing tendency to introduce surgery into orthopaedics. He said: "To mingle surgery and mechanics is to endanger both." (1891.) A zealot in maintaining his own views of correct treatment, he forbade Dr John Ridlon, his junior on the orthopaedic staff of St. Luke's Hospital to apply a Thomas hip splint, and thus drew down upon himself the righteous anger of Hugh Owen Thomas who wrote a scathing article condemning "the censor at St. Luke's Hospital." After his replacement at the New York Orthopaedic Hospital by Russell Hibbs, he established the New York State Reconstruction Home at Haverstraw for the care of crippled children. His personal animosity to Russell Hibbs and his position of authority in the councils of the American Medical Association resulted in the exclusion of Hibbs from the Association for many years.

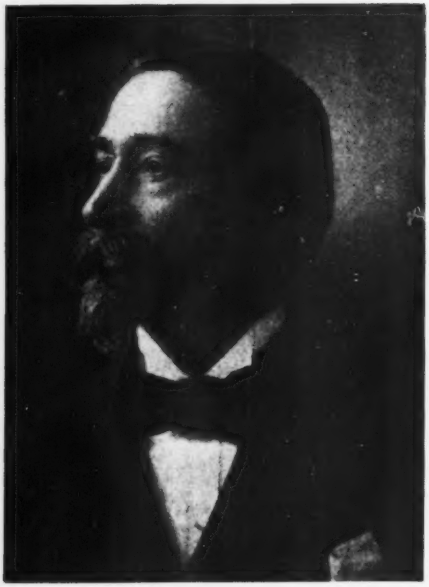
Dr Edward H. Bradford (1848–1926)



One of the most vigorous of the "founding fathers," the third president of the American Orthopaedic Association (1889), professor of orthopaedic surgery at the Harvard Medical School 1903. He had a mind of unusual maturity and originality. His study of club-feet published sixty years ago might well be used to-day in an orthopaedic instructional course. Besides his great technical contributions, particularly to the treatment of tuberculous coxitis and of congenital hip disease, he introduced the "social point of view" into orthopaedic surgery by helping found the Industrial School for Crippled and Deformed Children in Boston (1894), and established the principle of preventive medicine in orthopaedic urgery by his campaign for correct shoes and adequate seating of school children. His amazing industry is attested by the publication between 1887 and 1902 of 105 original papers, a text-book, and numerous articles on orthopaedic progress in the *Boston Medical and Surgical Journal.*

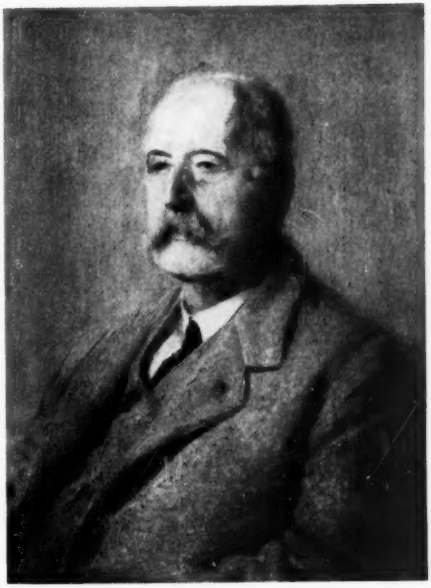
Dr DeForest Willard (1846–1910)

Professor of orthopaedic surgery at the University of Pennsylvania Medical School, a "founding father" of the American Orthopaedic Association, and its fourth president (1890). A man of great physical and mental powers, he developed such surgical dexterity that he could perform six osteotomies for rachitic deformities at one sitting without danger to his patients. He established the first ward for crippled children at the University Hospital and was largely responsible for the endowment of the Widener Memorial School for Crippled Children, of which he was Surgeon-in-Chief until his death in 1910.



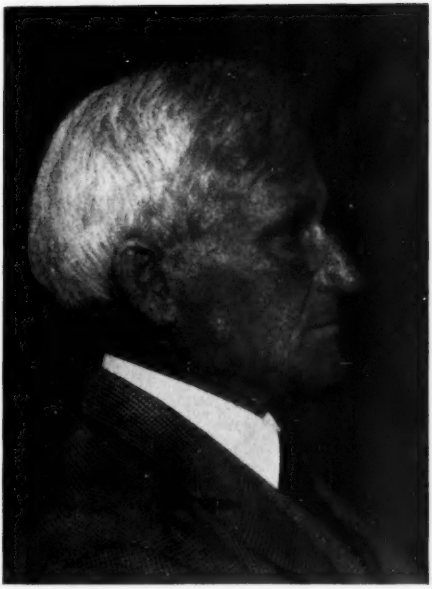
Dr Aaron John Steele (1835–1917)

A "founding father," professor of orthopaedic surgery in Washington University School of Medicine, St Louis, president of the Association in 1893. Intensely active and enthusiastic, a fine mechanic and an even better surgeon, he was, in the words of Drs Philip Hoffman and Nathaniel Allison, "ideally fitted for the practice and development of orthopaedic surgery, especially for those pioneer days." Known for his "ready wit and quickness of repartee, his kindness to patients, and 'especially his love for and tenderness toward children,' he was also widely recognised as 'one of America's best connoisseurs of old prints and engravings.'"



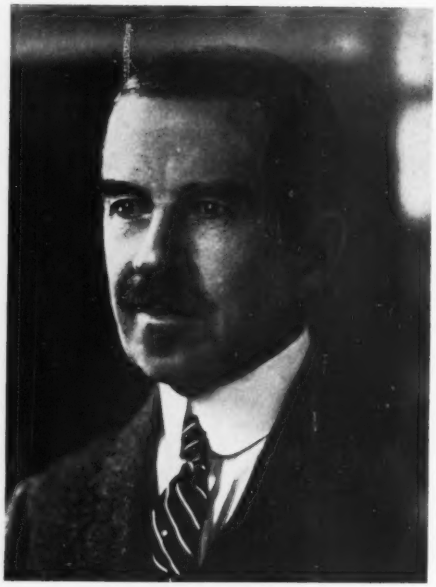
Dr John Ridlon (1852–1936)

Professor of orthopaedic surgery in the North-Western University Medical School, Chicago, a "founding father" and president of the American Orthopaedic Association in 1895. A warm friend of Hugh Owen Thomas and Robert Jones, he became a staunch supporter of their fixation method of treating tuberculous coxitis as contrasted to the traction method. In the Association discussions, which were at times quite acrimonious, he was always in the minority but never wavered in his opinions. He believed in leaving tuberculous abscesses alone—"not one in a hundred will cause trouble." He started practice in New York, but because he could not get along with Dr Newton Shaffer at the St. Luke's Hospital, he moved to Chicago where he became a distinguished teacher and attending orthopaedic surgeon to the St. Luke's, Michael Reese, Wesley and Evanston Hospitals. During the first world war he served as major.



Dr Royal Whitman (1857–1946)

Caustic of tongue and brusque of manner, his brilliant intellect, his unusual powers of exposition and his scientific zeal made him one of the outstanding orthopaedic surgeons of all time. Although he is known chiefly for his abduction treatment of fractures of the femoral neck and for his astragalectomy for calcaneus deformity, Whitman's early papers on weak foot, adolescent coxa vara, Morton's toe, and torticollis are important contributions to orthopaedic progress. In his address as president of the American Orthopaedic Association in 1896 he formulated the first modern concept of orthopaedics as "that division of surgery which treats of disabilities and diseases of the locomotive apparatus and of the prevention and treatment of deformities of the framework of the body."



Dr Robert W. Lovett (1859–1924)

One of the founders of the American Orthopaedic Association and president in 1898; professor of orthopaedic surgery at the Harvard Medical School. He combined great clinical gifts with an unusual flair for research, as evidenced by his study of the mechanics of scoliosis. He was a skilful administrator, an eloquent teacher, a fluent writer and an orthopaedic statesman who helped shape the policies and control the personnel of many medical schools besides his own. He was particularly interested in poliomyelitis and in 1916 helped to create the Harvard Infantile Paralysis Commission whose activities he directed for many years. He served as consulting orthopaedic surgeon to the Board of Health of New York City during the 1916 epidemic and developed the program of aid in that city as well as in Massachusetts and Vermont.

Dr Harry M. Sherman (1854–1921)

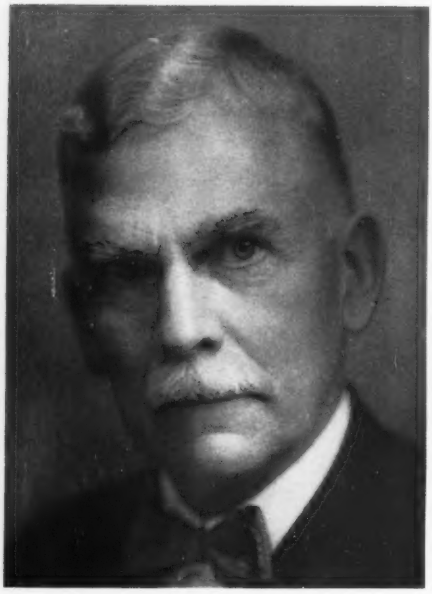
Clinical professor of orthopaedic surgery in the medical department of the University of California. Elected to the American Orthopaedic Association in 1889, he became one of its most active members and in 1900 was elected president. An original thinker, a brilliant surgeon and an honest seeker after truth, he refused to accept the current methods of treatment. He was one of the first to advocate early operation in tuberculosis of the hip (1893) because of the slow unsatisfactory course of cases treated conservatively. He practised excision of the knee in children and took care to conserve the epiphysial cartilage (1897). He had the courage to report unsatisfactory results with the Lorenz reduction of congenital hip dislocation at a time when other orthopaedic surgeons were lavish in their praise of the method. His presidential address was devoted to the same theme as that of his modern successor, Le Roy Abbott—the place of orthopaedic surgery in the medical school curriculum.

Dr Arthur J. Gillette (1864–1921)

Elected to the American Orthopaedic Association in 1889, he became president in 1901. Professor of orthopaedic surgery in the Minnesota State University, attending orthopaedic surgeon at numerous hospitals, he devoted much of his life to developing state aid for crippled children. Through his efforts the Minnesota State Hospital for Crippled and Deformed Children was opened in 1897, and he served as its chief surgeon for many years. In his presidential address on "Injuries to the Spine" he showed great clinical acumen, refuting the current claim that "it was impossible for a man to have a fracture of the vertebrae or a dislocation without a cord involvement which would be manifest." In the presence of paralysis he considered laminectomy futile. "Complete immobilization should be the surgeon's aim."

Dr Reginald H. Sayre (1859–1929)

Son of Lewis A. Sayre, he shared his father's enthusiasm for orthopaedic surgery. One of the "founding fathers" of the Association, he served as its president in 1904. His address was devoted to the theme of preventive medicine as applied to orthopaedic surgery. "We have been content," he said, "to go on year after year trying to correct all manner of deformities, many of which from their very nature can at best be ameliorated but never cured, and have done but little to teach the medical profession that early diagnosis is the secret of success in the treatment of deformities." That he was an ingenious surgeon is attested by his cure of a club hand (1893) due to congenital absence of the radius by the shift of the ulna to the middle of the carpus. In addition to his orthopaedic attainments he was a noted marksman and for a number of years held the American championship for small arms.

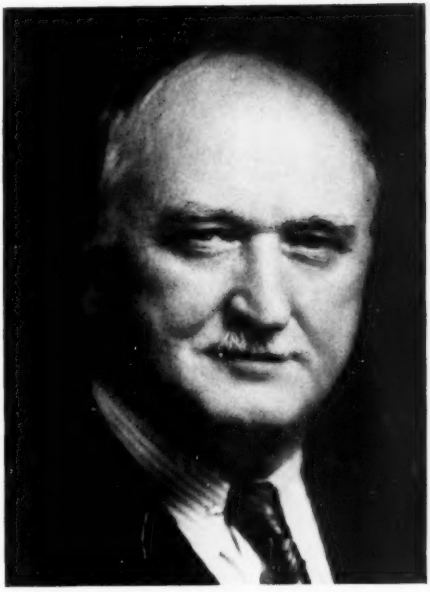


Dr Joel E. Goldthwait (1866–)

Elected to the American Orthopaedic Association in 1892, he is the oldest living member of the Association. Recognizing early the importance of orthopaedic surgery as a speciality, he raised the necessary funds to equip the first orthopaedic ward at the Massachusetts General Hospital. His studies of the sacro-iliac and lumbo-sacral joints, and his papers on posture have become classics. As chairman of the "Preparedness Committee," appointed in 1916, he organized the first group of American orthopaedic surgeons who sailed for England, April 28, 1917, just three weeks after the declaration of war, to work under Colonel Robert Jones. He was promoted to the rank of colonel in charge of the overseas division of the Department of Military Orthopaedic Surgery of which Colonel E. G. Brackett was the director.

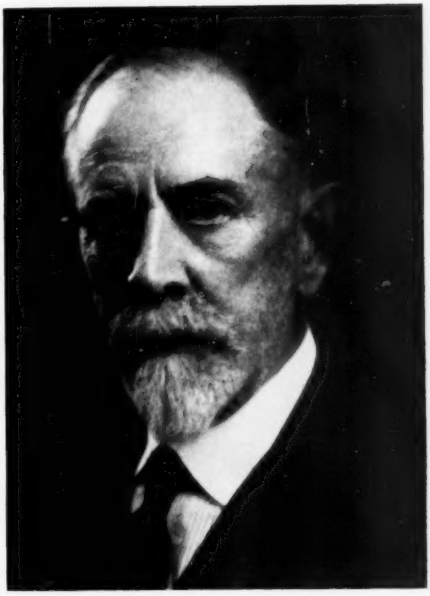
Dr Gwilym G. Davis (1857–1918)

Professor of applied anatomy at the university of Pennsylvania until his appointment as professor of orthopaedic surgery in 1910. Educated here and abroad, he combined scholarly knowledge with "originality and inventiveness" (Bruce Gill). Of his many contributions, the most important was the "horizontal transverse section of the foot"—an operation designed to correct and stabilize paralyzed feet (1913). He devised a method of reducing congenitally dislocated hips which was less traumatic than that of Lorenz, and an ingenious operation "to correct external or internal rotation of the lower extremity by suturing the fascia lata to the great trochanter." Dr Frank Dickson, Dr DeForest P. Willard and Dr Bruce Gill received much of their early training under Dr Davis.



Dr Fred H. Albee (1876–1945)

A mechanical genius who invented the motor saw, and devised scores of ingenious bone operations which he performed with the skill of a master craftsman. His outstanding contribution—spine fusion by the tibial graft for Pott's disease, published in the same year as the Hibbs operation, precipitated a rivalry between the two surgeons which after many years of heated discussion ended happily in the appointment of Albee's son as a resident in the New York Orthopaedic Hospital. His book, *Orthopaedic and Reconstruction Surgery* (1919), is a milestone in orthopaedic progress. As president of the American Orthopaedic Association in 1929 he led a group of Americans across the waters to hold a joint meeting with the British Orthopaedic Association, an occasion of goodwill and friendliness which has done much to cement the bonds between the two associations.



Dr Russell A. Hibbs (1869–1932)

Appointed in 1898 by the directors of the New York Orthopaedic Hospital to replace Dr Newton Shaffer, he represented the new school of orthopaedic surgery as contrasted to the old "strap-and-buckle" period. He disproved Shaffer's theory that "mechanics and surgery could not be mingled."

His concept of early fusion as the most effective treatment of joint tuberculosis has dominated orthopaedic thinking for the past forty years, just as his technique of spine fusion—published in 1911—has formed the basis for our modern methods of spine surgery.

Dr Albert H. Freiberg (1868–1940)

Organizer of the department of orthopaedic surgery of the College of Medicine of the University of Cincinnati, and its first professor (1902), elected to membership of the American Orthopaedic Association in 1902 and president in 1911. His knowledge of parliamentary law was such that he was called to take the chair in executive sessions of the American Orthopaedic Association when complicated situations were anticipated. A careful, judicious surgeon, he was never swept off his feet by a temporary wave of enthusiasm but ever retained a critical attitude. As chairman of the Association committee to investigate scoliosis, 1914, 1915 and 1916, he showed objectivity and mature powers of judgment. His Robert Jones lecture (1937) on "Orthopaedic Surgery in the Light of its Evolution" showed a grasp of the subject which might well earn him the title of "the philosopher of orthopaedic surgery."

Dr John L. Porter (1864–1938)

Professor of orthopaedic surgery in the University of Illinois Medical School, president of the American Orthopaedic Association during the first world war (1918). Treasurer of the American Orthopaedic Association for twenty-six years, his annual financial reports were models of clarity and brevity. He had the rare gift of imparting eloquence to a column of figures. He was a warm supporter of the *Journal of Bone and Joint Surgery* and a close friend of Dr E. G. Brackett. He helped to found the Central States Orthopaedic Club (1912) and became its first president. His life was characterized by courage, honesty and kindness. "His name will stand at the head of the list," concludes the tribute published in the Journal, "of those who have been pre-eminent in their love for their fellow men."

Dr Michael Hoke (1874-1944)

President of the American Orthopaedic Association in 1926. Son of a noted Confederate general, he combined the courtesy and culture of a southern aristocrat with a love for humanity and a passionate desire to help the crippled. In 1920 he enlisted the support of "The Shriners"—a Masonic order—for the erection and maintenance of hospitals for crippled children. As the orthopaedic physician of Franklin D. Roosevelt he was largely instrumental in establishing the Warm Springs Foundation. Though his first major contribution to orthopaedic surgery dealt with the operative correction of a severe case of scoliosis, he is best known for his work on the foot: first, his paper on the treatment of severe recurrent talipes equinovarus (1911); second, his stabilization operation for paralyzed feet (1921).

Dr Willis C. Campbell (1880–1941)

President of the American Orthopaedic Association in 1931, and president of the American Academy of Orthopaedic Surgeons at its first independent meeting, 1934. Beginning his medical career as a pediatrician, his mechanical talent and innate surgical inclination led him into the orthopaedic field, where he soon became an acknowledged master. Arthroplasty, bone grafting, the operative treatment of paralytic deformities, the management of fractures and the operative treatment of low back pain all owe much of their growth to his contributions. His clinic in Memphis, Tennessee, became a Mecca for southern patients requiring orthopaedic care and for students eager to work under so gifted a teacher.

PART IV

The Years of Maturity

Pathology . . . . . HENRY L. JAFFE
Technical Advances
Arthroplasty
Arthrodesis
Osteotomy of the Femur . . . . . HENRY MILCH
Bone Grafting
Surgery of Poliomyelitis
Recurrent Dislocation of the Shoulder . . . . JESSE T. NICHOLSON
Congenital Dislocation of the Hip
Control of Bone Length . . . . . WALTER BLOUNT
Back Pain and Sciatica . . . . . JOSEPH BARR
Scoliosis
Fractures of the Neck of the Femur
Other Fractures
Surgery of Tendons and of the Hand
Biochemical Advances
Scientific Progress . . . . . AARON BODANSKY
Clinical Applications
Osteomyelitis
Tuberculosis . . . . . CHARLES SUTRO
Arthritis . . . . . OTTO STEINBROCKER
Cerebral Palsy . . . . . WINTHROP PHELPS
Muscle Relaxants . . . . . EDWARD SCHLESINGER
Development of New Societies and of Orthopaedic Education
American Academy of Orthopaedic Surgeons . . . . CARL BADGLEY
American Society for Surgery of the Hand . . . . JOSEPH BOYES
Undergraduate Education . . . . . LEROY ABBOTT
Postgraduate Education. . . . . A. R. SHANDS
American Board of Orthopaedic Surgery . . . . . ALLEN F. VOSHELL
Orthopaedic Research . . . . . VERNE T. INMAN
Public Health Programs for the Orthopaedically Handicapped SAMUEL WISHIK
Lay Societies
The National Foundation for Infantile Paralysis . . . DOROTHY DUCAS
The Second World War . . . . . Major-General N. T. KIRK
Veterans' Administration Hospitals . . . . . PAUL MAGNUSON
Rehabilitation . . . . . HOWARD RUSK
Committee on Artificial Limbs. . . . . RUFUS ALDREDGE
Summary

In planning this last section your reporter has encountered the difficulty which must be evident to every reader: so much has happened that a mere chronological register of advances in technique—operative, mechanical, diagnostic, sociological and administrative—would fill several volumes. Nor is it advisable to attempt an encyclopaedic account of these thirty years; that would be beyond the function of this paper. It may, however, be of some interest and educational value to trace certain developments of orthopaedic thought and technique; to stress the importance of The American Academy of Orthopaedic Surgeons, of The American Board, of The American Society for Surgery of the Hand and of other orthopaedic groups; to note the advances in educational standards and the extension of orthopaedic surgery to almost all the medical schools; to report some of the significant contributions to pathology, chemistry and biophysics; to read General Norman Kirk's account of the part orthopaedic surgery played in the second world war, and Dr Magnuson's tale of the Veterans' Hospitals. In carrying out this plan, many friends have helped and to all of them I now extend my warm thanks.

It will also be necessary, because of the complexity of the subject, to abandon the narrative style of Parts I and III and adopt instead presentation by topics. Unfortunately this method of procedure has one obvious disadvantage: many contributions of great importance cannot be referred to. This is a source of great concern for fear that it may cause disappointment to some whose work deserves recording. For such omissions I now express my regrets and my apologies.

In another respect this account is sure to be deficient: it cannot bring out clearly the full educational, sociological, industrial and legislative significance of modern orthopaedic surgery, a development which has been so effectively presented by Sir Harry Platt in his "Evolution and Scope of Modern Orthopaedics." He emphasizes the "varied and humanistic experience which has determined the attitude of the orthopaedic surgeon of to-day towards the art and science of medicine as a whole, and which has made him strive to become something more than a mere specialist in either diagnosis or craftsmanship." It is to be hoped, however, that in the succeeding pages the reader will find more than a mere citation of technical advances, and that he will sense the myriad ramifications of our speciality and its significance not only in medicine but in the life of the community.

Since progress in orthopaedic thinking is to a great extent predicated upon a more exact knowledge of pathology the first section of Part IV will be devoted to that subject.

PATHOLOGY

Some Recent Advances

HENRY L. JAFFE, NEW YORK

A comprehensive discussion of skeletal disease from this point of view is, of course, quite out of the question here. We shall limit ourselves, therefore, to a few disease categories, and attempt to show how the pathologist's conception of them has been moulded and modified in the course of medical evolution during the past thirty-five years.

Hyperparathyroidism—That hypoparathyroidism induced by parathyroprivia leads to a prompt drop in the serum calcium level and to the appearance of tetany was discovered in 1909. This fundamental finding gave the clue to the relation of parathyroid function to calcium (and hence necessarily skeletal) metabolism. Its larger applications in the field of skeletal disease were not fully realized, however, until about 1925. It is true that before that time pathologists already recognized that in cases of so-called generalized osteitis fibrosa cystica of Recklinghausen, and also in some cases of so-called severe osteomalacia, one or more of the parathyroid glands would usually be found to be greatly enlarged. However, the parathyroid enlargement found in these cases, and even its suspected hyperfunctioning, were generally considered to have arisen in response to the skeletal devastation, and it was not realized that hyperfunction of the parathyroids itself instigated the devastation.

In 1926 a case of Recklinghausen's bone disease was treated for the first time on the supposition that it might be based upon parathyroid hyperfunction, a dramatic improvement being obtained through removal of an enlarged adenomatous parathyroid in this case. The aforementioned clinical advance was concomitant with the development of chemical methods for the preparation of potent parathyroid extracts. Clinical and experimental studies soon proved that with such extracts one could duplicate the clinical (including biochemical) and the pathological aspects of the bone disease hitherto known as Recklinghausen's osteitis fibrosa cystica. Thus it became established that parathyroid hyperfunction was the fundamental disorder and that generalized osteitis fibrosa cystica of Recklinghausen represented merely the extreme skeletal expression of hyperparathyroidism. Soon thereafter it also began to be evident that cases of hyperparathyroidism really fall into two subdivisions. One group, primary hyperparathyroidism, is constituted by cases in which there is no direct explanation or known cause for the parathyroid hyperplasia and hyperfunction. The other group, secondary hyperparathyroidism, is constituted by cases in which there is a direct explanation or known cause for the parathyroid hyperplasia and hyperfunction. Specifically, for practical purposes secondary hyperparathyroidism is hyperparathyroidism appearing in response to chronic renal insufficiency ascribable to any one of several pathologic causes such as congenital polycystic kidneys, congenital ureteral strictures or chronic glomerular nephritis. Thus the changes associated with so-called renal rickets and renal dwarfism of early childhood had come to be recognized: and even in adults chronic renal insufficiency, through its instigation of parathyroid hyperfunction, may be reflected in resorption and fibrosis of the bones, occasionally even reaching a high degree.

Collateral results of delineation of the concept of hyperparathyroidism—The concept of hyperparathyroidism was the entering wedge which brought about the collapse of the former infertile though widely accepted classification of many of the systemic bone diseases under the general vague heading of " fibrous osteodystrophy," modified merely by the descriptive term " hyperostotic " or " hypostotic." For instance, in that system Recklinghausen's disease of bone represented the hypostotic and Paget's disease the hyperostotic form of fibrous osteodystrophy, as though the two disorders were not fundamentally distinct. The finding that patients suffering from primary hyperparathyroidism tended to have distinctive serobiochemical patterns in regard to calcium, inorganic phosphorus and alkaline phosphatase stimulated intensive study of these patterns in regard to these substances in other skeletal disorders. Previously only the serum calcium and inorganic phosphate values had received study, and these only in connection with rickets. The serum biochemical pattern characterizing hyperparathyroidism was soon established as hypercalcemia, hypophosphatemia and an elevated serum phosphatase activity value. The pattern for secondary hyperparathyroidism was established as a tendency toward hypocalcemia, definite hyperphosphatemia, an elevated alkaline phosphatase and an elevated non-protein nitrogen value. Rickets and osteomalacia were found to be characterized by a tendency of the calcium value to be normal or at most slightly below normal, for the phosphate to be definitely below normal and for the alkaline phosphatase to be elevated. Paget's disease was found to be characterized biochemically only by an elevated alkaline phosphatase value, and the condition which is now generally recognized as fibrous dysplasia of bone also only by an elevated alkaline phosphatase value, though one which, even when the disease is very extensive, is not as high as that which is characteristic of advanced Paget's disease. However, along more purely clinical lines, and in the field of tissue pathology, much progress in the understanding of the disorders (other than hyperparathyroidism) has also been made during the past twenty-five years.

Paget's disease—In connection with this disease the most significant advance is the recognition that circumscribed calvarial osteoporosis is part and parcel of the total picture of Paget's disease. Roentgenologists had recognized that in the calvarium, particularly of older persons, large, clear-cut, relatively radiolucent areas may appear, while at the same time the thickness

of the calvarium in the affected area remained within normal limits. Gross anatomic examination of the calvarium in such cases showed that these radiolucent areas appeared purplish or reddish. Histologic study showed that the tables and diploic bone in these areas were thinned and the osseous tissue tended to present the mosaic tissue pattern of Paget's disease. Systematic study of such cases subsequently showed that these altered calvarial areas eventually, though slowly, became sclerosed and thickened, and came to show also the rather typical roentgenographic and gross anatomic pattern of Paget's disease. Thus circumscribed calvarial osteoporosis was definitely established as an early porotifying phase of Paget's disease of the calvarium.

Rickets and osteomalacia—Almost nothing has been added to what was already known by about 1915 concerning the gross and microscopic pathology of infantile rickets. Its etiology on the other hand was still unknown at that time, although on a vague pragmatic basis cod-liver oil was sometimes used in its treatment, especially in fishing communities. With the end of the first world war a very intensive campaign of experimental investigation in the field of rickets was undertaken. On the basis of growing knowledge about calcium and phosphorus metabolism, and the discovery of means of inducing rickets experimentally (especially in rats) the first concerted steps toward conquering it were made. The discovery of the value of irradiated ergosterol in the prevention and cure of experimental rickets led to the identification of vitamin D and then to its chemical synthesis. The wide application of the administration of vitamin D to infants soon brought about a striking drop in the incidence of this disease. Indeed, a case of full-blown infantile rickets is now a rarity in those parts of the world where it was indigenous and where vitamin D is now used prophylactically.

Osteomalacia as the strict adult counterpart of vitamin D deficiency rickets of infants was probably always a rare disease. Those instances of osteomalacia which did appear among the adult population can be said in general to have been based on deep-rooted nutritional disorders in the form of deficiencies in mineral and protein intake or absorption, in addition to any vitamin D deficiency. This general statement is also true for the osteomalacia which sometimes occurred in connection with idiopathic steatorrhoea of adults, coeliac rickets of children, and the rickets or osteomalacia associated with the presence of biliary and pancreatic fistulae.

Although rickets on these various bases has come to be understood and in large measure conquered the past fifteen years have seen a renaissance of interest in the subject. This stems from the discovery that rickets and osteomalacia may arise not only on the basis of a vitamin D deficiency but also through renal tubular dysfunction (without disease of the glomeruli). In the case of rickets arising through dysfunction of the renal tubules the dysfunction may consist of defective tubular resorption or defective tubular excretion. We are only at the threshold of understanding of the pathologic physiology of these cases, but what we have learned so far does represent progress in that it explains the intractability to vitamin D of certain cases of rickets and osteomalacia which the orthopaedist occasionally encounters.

Fibrous dysplasia—This is another condition which has recently (1937 and 1938) been rescued from the amorphous category of fibrous osteodystrophy. Furthermore in its advanced form it is no longer confused, as it used to be, with generalized osteitis fibrosa cystica of Recklinghausen (the skeletal expression of hyperparathyroidism). As is now being increasingly recognized, what is meant by fibrous dysplasia of bone is the presence in one bone (solitary lesion) or in several or many bones (polyostotic form) of a fibro-osseous replacement tissue sometimes containing islands of hyaline cartilage or areas of cystic softening or both. In association with the bone involvement many patients present cutaneous pigmentation and some few present premature skeletal maturation and even precocious puberty with or without hyperthyroidism. These full-blown cases are some times denoted as instances of " Albright's disease."

The term " fibrous dysplasia of bone " actually denotes only the dysplastic skeletal

changes common to all cases. As applied to the disease complex as a whole, however, it has the value of emphasizing the basic and constant feature of the disease while permitting modifications in accordance with the special features of individual cases. Moreover it is also worth noting in regard to nomenclature that instances of fibrous dysplasia have in the past been designated as focal, unilateral or disseminated " osteitis fibrosa," according to the extensiveness of the bone involvement. Also, they have been denoted as " fibrocystic disease of bone," and sometimes even as a form of Recklinghausen's disease of bone. In regard to fibrous dysplasia of the jaw bones, the terms " fibrous osteoma " and " ossifying fibroma " are the ones which have most often been applied.

Eosinophilic Granuloma of Bone—The concept of eosinophilic granuloma of bone was delineated in 1940. The disorder has come to be recognized as a peculiar inflammatory condition affecting one, several or many bones. Whether single or multiple, the skeletal lesions occupy the foreground of the disease picture. In the cases in which only one bone lesion develops, the lesion heals either spontaneously or under treatment and there is no further trouble. This is true also in most of the cases showing multiple bone lesions.

The delineation of the concept of eosinophilic granuloma of bone opened up a number of questions which have not yet been settled. One of these is the possibility of the identity of cases of multiple eosinophilic granuloma with many of the cases already reported in the literature under the heading of Schüller-Christian disease. In this connection, the further question arises of the actual pathologic nature of Schüller-Christian disease itself, since neither Schüller nor Christian had presented any relevant gross or microscopic pathologic findings. The question also arises whether, and if so how, eosinophilic granuloma is related to Letterer-Siwe disease. At any rate, whatever the anatomic interrelations among these three conditions may be there does seem to be a need for retaining at least clinical distinctions among the three, especially since eosinophilic granuloma is a relatively innocuous clinical condition.

Giant-cell tumor—This lesion continues to be the " problem child " among the benign tumors of bone. This is true even though, in accordance with more recent knowledge, the term " giant-cell tumor " is generally being used rather strictly. Specifically, it is no longer being made a catch-all for various other tumorous lesions formerly included among the giant-cell tumors, albeit as variants, merely because they contain some multinuclear giant cells. The genuine giant-cell tumor remains a lesion difficult to assay in respect to its clinical behaviour. In general it can be said now, however, that it very frequently recurs after any form of local therapy, and that instances of metastasis from giant-cell tumor are increasingly being recorded. Thus the giant-cell tumor is actually a rather treacherous lesion, in regard to which the term " benign," still often made part of its name, conveys a false conception of its potentialities. Whether a particular giant-cell tumor will recur cannot necessarily be predicted from the histologic pattern of the lesional tissue. Indeed, it has been found that it may recur or even metastasize when the pattern is not in itself such as to create uneasiness. Thus an occasional giant-cell tumor runs a malignant course without presenting, even in its metastases, an obviously malignant histologic pattern. Nevertheless, in most cases of malignant giant-cell tumor the stromal tumor tissue does present a sarcomatous appearance. Sometimes this appearance is already manifest in the original local tumor, and sometimes it does not become so until after repeated local recurrence.

Chondrosarcoma—It is now generally recognized that chondrosarcoma of bone is an entity distinct from osteogenic sarcoma. It is a malignant bone tumor which arises from cartilage and tends to maintain its essentially cartilaginous nature as it continues to grow. It is possible to show, in regard to many chondrosarcomas, that they arise through malignant degeneration of a previously benign cartilage tumor—in particular through malignant degeneration of an enchondroma or an osteochondroma (osteocartilaginous exostosis). The transformation of a benign cartilage tumor into a frank chondrosarcoma is often slow, and even after this the sarcoma often remains only locally invasive for years. On the other hand it is not unusual

for the transformation to be achieved rather quickly and for the case to run a rapid course, terminating in death within a year or so.

Ewing sarcoma—The Ewing sarcoma is a specific primary malignant tumor of bone. As to pathogenesis, it was originally thought that the tumor cells of the lesion were derived from angio-endothelium in the broadest sense, and hence the lesion was originally designated as "diffuse endothelioma" or "endothelial myeloma" of bone. The present tendency is to favor the interpretation of the tumor as a sarcoma of a primitive form of connective tissue, and specifically of the mesenchymal supporting framework of the bone marrow. This conception of the histogenesis of the tumor cells seems to be superseding the one proposed originally.

Osteoid osteoma—The small but painful benign bone lesion known as osteoid osteoma was first defined in 1935. It is a sort of borderline or quasi-tumor. The fact that it is a lesion of self-limited growth, irrespective of its duration, is of course somewhat against its being acceptable as a tumor. On the other hand it clearly does not represent, for instance, a reparative response to an inflammation. At any rate it is now generally accepted as a distinct lesion and one which should not be confused, as it still sometimes is, with a small bone abscess or a focus of chronic sclerosing non-suppurative osteomyelitis.

Tumors developing at sites of damage from noxious agents—In relation to the bones, there have been many clinical and experimental observations of both the immediate and remote harmful effects of the external application of roentgen and radium rays. It has been clearly established that if, for therapeutic purposes, one or more long bones, for instance, of a young child have been irradiated with too large a single dose, or at too frequent intervals, the bone or bones in question may become stunted because of damage to the epiphysial cartilage plate areas. In a child or in an adult (in whom, of course, the plates no longer exist) intensive external radiation is known to induce injury to the other bone elements also. That is, it may damage the periosteum, bone marrow, spongy bone and cortex. The complex of changes which may appear under these conditions is usually termed "radiation osteitis." This involves necrosis and sclerosis of the osseous tissue and fibrosis of the bone marrow. The bones so affected also become brittle and highly susceptible to fractures (which are also slow in uniting) and to infection.

That a sarcoma may develop in a bone which has been heavily irradiated has become increasingly evident as experience accumulates. There is quite likely to be an interval of five years or so between the time of the intensive irradiation and the appearance of the malignant tumor. Sarcoma has been known to develop in a bone which had been heavily irradiated in the treatment of an infection (tuberculosis, for instance), a non-malignant tumorous bone lesion (such as a giant-cell tumor or a bone cyst) and even in an originally sound bone which had been within the field of irradiation. Though the incidence of post-irradiation sarcoma is apparently not high its occurrence cannot be doubted and should be a deterrent to irradiation of benign bone lesions which could be treated by surgery instead. These experiences are in line with the earlier observations on the development of bone sarcomas in persons who, years before, had either ingested or inhaled salts of radium of mesothorium, the salts having lodged in the bones and first induced a radiation osteitis.

Infantile cortical hyperostosis—In 1947 the entity of infantile cortical hyperostosis was delineated. This affection, not particularly rare, appears in infants of about three or four months of age. It sets in with swellings of the soft parts overlying various bones, and these are soon followed by the appearance of an osteoperiostitis of the underlying bone. Very often the mandible is the first bone affected; but a number of other bones may soon become involved. The course is one with remissions and exacerbations, certain of the bones showing recession of the osteoperiostitis while others are developing it. After a period of six months or a year the disease usually comes to a spontaneous arrest.

Infantile cortical hyperostosis seems to be a new disease entity. It is not likely that it had previously been confused with the osteoperiostitis of congenital syphilis and the

subperiosteal new bone formation associated with healing scurvy. The cause of the disease remains an enigma.

Aseptic necrosis of bone—The groundwork for the study of aseptic necrosis of bone was laid in the experimental studies carried out years ago on the fate of bone transplants. These studies helped to develop the concept of "creeping substitution"—that is, of the process by which bone which has been transplanted into a host and died is gradually replaced by new bone. It is through creeping replacement that a bone graft used for instance in fusion of a vertebral column comes to be transformed into host bone.

The concept of aseptic necrosis and creeping substitution soon found its applicability in explaining the basic pathologic alterations taking place in the capital femoral epiphysis in cases of Perthes disease. The immediate change was shown to be an aseptic necrosis of a smaller or larger part of the femoral epiphysis. The later reparative changes were found to be dependent on revascularization and creeping replacement of the dead bone by living bone.

What has remained a mystery, however, in connection with the localized aseptic necrosis has been the manner by which the blood supply to the affected bone area is interrupted. The idea that the blood supply to the part was interrupted through the plugging of the terminal arteries by bland bacterial emboli found many adherents. It has never been proved, however, and has now been largely discarded. All one can say is that in some way trauma plays a part in the evolution of the alterations leading to death of the bone in localized aseptic necrosis such as occurs in the capital femoral epiphysis, the condyle of the femur, the carpal lunate, the head of the second metatarsal bone and other sites.

In connection with infarction of the bone as observed in caisson workers, embolization of terminal arteries by bubbles of nitrogen seems to be the mechanism by which the aseptic necrosis of bone is instigated. Bone infarction, expecially if the infarction extends to an articular bone end, may lead to collapse of the bone end, articular incongruity and the development of osteoarthritis. In this way the painful joints of caisson workers are to be explained. The occasional occurrence of bone infarction in solitary and multiple foci in persons who are neither caisson workers nor high altitude fliers has been noted and requires further investigation.

TECHNICAL ADVANCES

ARTHROPLASTY

One of the most intriguing fields of orthopaedic endeavor has been the creation of a new joint to replace one destroyed by disease or accident. Though a first attempt was made by J. Rhea Barton in 1826 the subject did not engage serious surgical consideration in America until the beginning of the twentieth century. Then from the group of general surgeons, represented by Dr John B. Murphy, and from the orthopaedic group, represented by Dr William Baer of Baltimore, frontal attacks were made. Murphy used a pedunculated flap of fascia and fat as interposition material. He considered the fat as important as the fascia; he thought the pedicle necessary for vascular supply. Baer (1909) considered the Murphy flap too bulky and after experimentation selected chromicized pig's bladder (Cargile membrane) as the most suitable interposition material. Allison (1915) used fascia impregnated with silver so as to render it more resistant. At a symposium of the American Orthopaedic Association in 1917 Baer presented satisfactory results in 68 per cent of arthroplasties of the hip, knee, elbow, jaw and other joints. Dr Melvin S. Henderson (1918), as the result of a questionnaire, reported that results were best for the jaw (93 per cent), next best for the elbow (76 per cent), then for the hip (57 per cent) and for the knee (15 per cent). The showing was not too encouraging.

Far better were the results of Dr W. Russell MacAusland of Boston, reported in his paper before the International Congress of Surgeons in London in 1923. He used fascia from which the fat had been carefully removed, and sutured this so as to cover one of the two articulating

surfaces. The elbow proved most amenable to arthroplasty and in thirty-one cases gave 90 per cent or more of painless motion.

A scholarly paper—the first Sir Robert Jones lecture of the Hospital for Joint Diseases—was delivered by Willis Campbell in 1931. Entitled " The Physiology of Arthroplasty," it presented the objective evidence regarding arthroplasty as seen in animal experiments, in clinical results, in observations after spontaneous new joint formation (as in pseudarthrosis), in biopsies and autopsies and in roentgenological studies. He considered 60 per cent of his operations successful. In six cases he had the opportunity to examine the newly formed joints months or even years later. In these he found a joint cavity containing fluid; the articular surfaces were covered by a smooth, firm fibrous tissue, which " may in time by functional adaptation be supplanted by cartilage."

An actual demonstration of cartilage, however, was not made until some years later, when by introducing a new principle into arthroplasty Dr M. N. Smith-Petersen of Boston was able to prove at secondary operations that hyaline cartilage actually formed in a man-made joint. The story of Smith-Petersen's work is so fascinating that it should be read in his own words. In his first paper published in this Journal in 1939 after fifteen years of experimentation first with glass moulds, then with pyrex and bakelite, he reported his first twenty-nine cases of vitallium-mould arthroplasty. His original idea was of a two-stage operation: the first for the insertion of the mould, the second, after a joint had been formed, for its removal. Further observation showed that the second operation was unnecessary, but the superiority of the mould to a perishable interposition material such as fascia or chromicized pig's bladder has been well established. To insert the mould Smith-Petersen modified slightly his subperiosteal supra-articular approach, first reported in 1917, and developed an adequate set of tools. He paid meticulous attention to the post-operative care of his patients. By nature a perfectionist, he has worked over each tiny detail of the operation until it actually seems to the observer to be the perfection of bone surgery. In his second important paper on the subject, the Moynihan lecture delivered in 1947 at the University of Leeds, he told of his experiences with more than 500 hips. He considers his operation better than arthrodesis for dealing with malum coxae senilis, rheumatoid arthritis and aseptic necrosis. He has also had much success with congenital dislocations. " This is the first time," he writes in his conclusions, " that the principle of the mould—the principle of guiding the repair of nature for the purpose of recreating a destroyed or damaged structure—has been applied to surgery."

Thus far it has not proven possible to extend this principle to the knee and to other joints where an improved method of arthroplasty is desirable.

Recently at the 1950 session of the American Orthopaedic Association, still another type of arthroplasty was presented—the Jaenichen method of substituting a metal ball for the femoral head. Peterson reported fifteen cases with good results but the method must still be considered in the experimental stage. A similar method of substitution has been demonstrated by McBride at the exhibits of the Academy of Orthopaedic Surgeons. Experimental and clinical investigation has been done at the Columbia College of Physicians and Surgeons on plastic substitutes for the femoral head, and in France an acrylic femoral head has been successfully used in several hundred cases by Drs Jean and Robert Judet, and also by Professor Merle D'Aubigné.

ARTHRODESIS

One of the procedures that have added greatly to the therapeutic effectiveness of the orthopaedic surgeon is the surgical production of ankylosis of the joints. Originated by Albert of Vienna, who coined the term " arthrodesis," it was first used to fuse a paralyzed shoulder and thus to transfer the action of the thoraco-scapular muscles to the arm. This principle of stabilizing a paralyzed joint was extended later to prevent progress of deformity, as in fusion of the spine for advancing scoliosis, and to act as an internal splint, thus eliminating joint motion and aiding the healing of tuberculosis and severe arthritis.

During the period under consideration fusion of all the major joints has been extensively practised. For the ankle and foot it has been used chiefly for paralytic conditions, but also for arthritis, particularly of the traumatic type induced by malunited fractures. The horizontal transverse section of G. G. Davis (1913) was succeeded by the brilliant operation of Hoke (1921) (already referred to) and by the triple arthrodesis of Ryerson (1923). Another principle, the bone block, was introduced by Willis Campbell (1923). The bone block was built up behind the tibia, resting in the talus and calcaneum; it was used in combination with subtalar arthrodesis to prevent dropping of the foot. All these operations, together with the Whitman astragalectomy combined with tendon transplants, have enabled the orthopaedic surgeon to correct practically all paralytic deformities of the feet.

For malunited fractures, with disorganization either of the talo-tibial or subtalar joints, arthrodesis relieves pain with a minimal loss of motion. At the talo-tibial joint the lateral approach of Horwitz, who used the resected fibula as a graft to fuse the tibia to the talus, or the anterior approach, with sliding graft from tibia to talus, gives excellent results. For fractures of the calcaneum involving the subtalar joint the posterior incision of Gallie with the introduction of two tibial grafts is simple and effective.

At the knee the actual enunciation of the principle of fusion for the cure of tuberculosis was first made by Hibbs in 1911, but we have seen that during the 'nineties there were numerous " resections " of the knee with resultant ankylosis and cure of the tuberculosis. Hibbs (1911) utilized the patella as a graft, Albee (1916) a sliding graft from the femur, Milgram (1931) a round graft removed with a special trephine from the adjacent surfaces of the femur and tibia. Bosworth substituted the Smith-Petersen nail for the less efficient nails and wires used by previous surgeons. American orthopaedic surgeons were quick to adopt the idea of Dr Albert Key, as advocated by Charnley at the Quebec meeting of the Association (1948), of utilizing a compression force so as to hold the femur and tibia in intimate contact.

Arthrodesis of the knee has been effective in severe chronic osteoarthritis and even in neurotrophic joints (Cleveland and Smith). For paralyzed knees the operation is used less and less because of the obvious superiority of a light brace which permits flexion in the seated position.

As to the hip, an intense controversy is still raging with regard to the comparative merits of arthrodesis versus arthroplasty in cases of osteoarthritis. Smith-Petersen in a personal communication has informed the author that within the past ten years he has not once been forced to resort to arthrodesis; other competent surgeons, however, prefer the more certain results of arthrodesis to the hazard of arthroplasty, even though arthrodesis unquestionably throws a severe strain on the lumbar spine, which frequently is also the seat of osteoarthritis. In cases of tuberculosis there is no doubt about the indication for arthrodesis. The method of Chandler, as reported by Pease (1948), has given unusually good results in children. In adults iliac grafts, reinforced by the Smith-Petersen nail (Watson-Jones) have been most effective. In paralytic conditions the operation has a place whose importance has thus far not been sufficiently recognized.

No part of the body is fused in modern orthopaedic surgery so frequently as the spine. Although thanks to the diminution in the incidence of tuberculosis the original purpose of the operation published by Hibbs and by Albee in 1911—namely the cure of Pott's disease—is now seldom invoked, the extension of fusion of the spine to cure painful back and to prevent the advance of scoliosis has made the operation very popular.

At the shoulder fusion is of inestimable benefit in paralytic cases. Although in certain instances transplantation of the trapezius or other muscles may be practised most of the extensive paralyses require arthrodesis. But the operation is indicated only if the trapezius, serratus magnus and other thoraco-scapular muscles are reasonably strong. Great care must be taken to place the arm in a functional position at the end of the operation (Pemberton 1942).

At the wrist, too, both in poliomyelitis and in the complicated lesions of the peripheral

nerves due to injury, fusion is an important adjuvant. The iliac graft of LeRoy Abbott (1947) is the most effective method.

OSTEOTOMY AT THE UPPER END OF THE FEMUR

HENRY MILCH, NEW YORK

The purposeful cutting of the upper end of the femur with the object of altering its axial alignment probably dates from 1827. In that year John Rhea Barton of Philadelphia first performed subtrochanteric osteotomy for the correction of a flexion adduction deformity in an ankylosed hip. For many years such anatomical correction of axial alignments presented the only indication for the use of the " directional osteotomy." No further significant progress was made until 1894 when Kirmisson suggested subtrochanteric osteotomy with the object of improving function in cases of congenital dislocation of the hip. After this the physiological implications of subtrochanteric osteotomy in the movable hip began to receive attention. In 1915 Hibbs performed detorsion osteotomy for the correction of anteversion of the femoral neck as had been recommended by Bradford in 1900. In 1918 von Baeyer, and in 1919 Lorenz, independently described a type of upper femoral osteotomy which has since acquired the designation " bifurcation operation." Because of its stabilizing effect on the pelvis this operation early acquired wide popularity. In this country good results were reported by Reich (1925) and later by Galland (1930). But subsequent experience has shown that it frequently resulted in annoying pain, limp and limitation of motion. While the explanation of these unhappy sequelae was not immediately apparent, the operation gradually lost favor and was soon superseded by a somewhat different type of " pelvic support osteotomy " first described by Schanz in 1922. This found a strong supporter in Gaenslen (1935) who considered it more effective than the Lorenz " bifurcation." Schumm also favored it.

Though both the Lorenz and Schanz procedures achieve pelvic stability by displacement of the mechanical axis with effectual exclusion of the femoral neck it was not until 1944, when the concept of the " post-osteotomy angle " was developed (Milch), that the reason for the superiority of the Schanz over the Lorenz procedure became evident. It was found that whenever the " post-osteotomy angle " exceeded the critical value determined by the inclination of the wall of the erect pelvis, stability and pelvic inclination were increased while mobility was correspondingly decreased. It was further found by differential amputation of the " bifurcation spike " that as the spike was made smaller and the Lorenz procedure tended to assume the appearance of the Schanz osteotomy pain, limp and the limitation of motion tended to disappear.

The appreciation of the kinesiological value of upper femoral osteotomy soon led to its application in a number of different conditions. In 1930 Putti began the use of the displacement osteotomy to support both head and neck of the femur by bridging across the fracture line in fractures of the femoral neck (reported in 1937). In 1935 Pauwels employed an abduction type of osteotomy with the object of changing the angular relationship of the fracture line to the axis of the femoral shaft and thereby converting a shearing stress into a compression force. At about the same time McMurray recommended a modified form of Lorenz bifurcation for the purpose of altering the line of weight-bearing in osteoarthritis of the hip. In 1943 Milch reported on the use, during the preceding nine years, of the resection-angulation operation in the treatment of the same condition. This operation, much like that described by Batchelor in England, was designed to effect: 1) release of the pelvis and restoration of hip mobility by resection of the femoral head and neck; and 2) re-establishment of pelvic stability by a Schanz type of osteotomy. It has since been employed in the treatment of a number of different hip affections. In 1947 Irwin again proposed the previously abandoned method of subtrochanteric osteotomy for the purpose of enforcing pelvic inclination and thus of increasing pelvic stability in cases of gluteal paralysis after poliomyelitis.

Recognition must be given here to the work of Trumble (1932), Brittain (1941) and

Bosworth (1942) who recommended various modifications of the subtrochanteric osteotomy for the purpose of accomplishing extra-articular ischio-femoral arthrodesis of the hip joint.

Many excellent techniques for predetermining the exact degree of axial deviation to be obtained and many different methods of fixing the fragments of the femur have been developed. Blount's (1943) modification of the Moore nail, in particular, has greatly simplified post-operative treatment.

BONE GRAFTING

Originated by a great French surgeon, Ollier, in his famous *Traité Experimentale et Clinique* (1867), activated by the brilliant contribution of Macewen of Glasgow in his monograph *The Growth of Bone* (1912), this branch of surgery has reached the peak of its development through the efforts of a group of American surgeons. The story is as exciting as a novel in which ardent rivals, men of blood and brawn, contend for mastery. Even to-day, after forty years of intense effort, all is not yet decided, but orthopaedic surgery has advanced because of the conflicting views.

The tale begins, as already told in Part III, in 1911 when within a few months there appeared two independent papers by two New York orthopaedic surgeons—Fred Albee and Russell Hibbs—each dealing with the application of bone grafting to fuse a diseased spine. Albee used a massive tibial graft which he removed with a motor-driven saw. The graft was placed between the two halves of the split spinous processes. No attention was paid to the intervertebral joints. Hibbs meticulously denuded the laminae of cortical bone, the intervertebral joints of cartilage, and utilized as bone grafts the spinous processes and the tiny bits of bone supplied by the denudation. Albee contemptuously referred to these grafts as " chicken-feed " but we now know that they possess much more osteogenic potentialities than the massive graft on which he was so insistent. Each surgeon was in his own right a master technician. Both achieved a remarkably high percentage of good results, and each kept to his own path, determined to show the other that his method was superior. Albee rapidly extended the use of the graft to fractures, recent, old and ununited, and to many phases of reconstruction surgery. Hibbs applied his method, with slight modifications, to fuse the hip, the knee and other joints. Albee developed the technique of the inlay bone graft with the finesse of a cabinet-maker. He favored the inlay because it appealed to his boyhood knowledge of tree grafting. He had noted how accurately the scion (graft) was fitted into its new bed so that each layer of the bark—alburnum, heartwood and heart—contacted the corresponding layer of the host. The same laws of growth must, he thought, hold true in bone grafting. Certainly his method worked; in 1930 he could report 89 per cent of cures in 754 cases. But Phemister of Chicago was able in 1931 to demonstrate by animal experiments and by clinical observations that the coaptation of the layers of the bone graft to the host was not essential. He found that in selected cases of non-union the inlay method was an unnecessary refinement and that healing could be secured by the simple expedient of wrapping osteoperiosteal grafts about the site of non-union or by applying two whole-thickness " splint grafts " after removal of the exuberant bone. In twenty-four cases of non-union treated by this method healing occurred in all.

Meanwhile Willis Campbell (1924) and Melvin Henderson (1928) had independently perfected the technique of the onlay graft. Albee disapproved of this type of graft because it did not correspond to his insistence on the coaptation of the layers of graft and host; because the onlay graft would add to the thickness of the recipient bone and thus cause undue strain on the skin suture; and because screws were necessary to secure the graft, and screws, he thought, diminished the strength of the graft because of the holes drilled for their insertion. Though proven wrong on all three counts, he continued to champion his method to the very end. The onlay graft, however, had come to stay, and in the hands of competent surgeons gave an even higher percentage of cures than the inlay; the Campbell Clinic (1942) for instance, was able to report over 93 per cent of cures in 511 cases of non-union (Boyd). Thanks to the work of

Venable, Stuck and Beach (1937) it was proven that screws of inert alloys such as vitallium in no way interfere with bone healing. This fact led to a further development: Harold Boyd's dual onlay bone graft—one of the most effective methods of treating congenital pseudarthrosis of the tibia and other types of non-union close to a joint. Boyd did not hesitate to use homologous grafts even though Albee insisted on the superiority of autogenous bone.

The success of the homologous graft was in part responsible for another important contribution—the use of refrigerated bone, first advocated by Alberto Inclan of Havana (1940). He preserved the bone in citrated blood or saline at a temperature of 37 to 40 degrees Farenheit. Of forty-three cases in which he was able to check the final result 73 per cent were successful. By using modern refrigeration with temperatures of minus 25 degrees Centigrade (Bush), or by immersing the bone in merthiolate solution, " bone-banks " have been established in many hospitals. Though some surgeons still prefer the autogenous graft—and the experimental work still shows it to be somewhat more reliable—the bone-bank is a boon to many patients.

A new idea in the technique of repairing large defects of the tibia and femur was presented by Flanagan and Burem (1947). Their purpose was the " reconstruction of the normal architecture of tubular bone at the site of the defect " by apposing two massive grafts each comprising one-half the circumference of the affected bone—the half-cylinder grafts first described by Hey Groves. Of twenty-one cases sixteen were successful, a high percentage considering the extreme difficulty of the reconstruction problem.

Of the recent contributions the most significant is that of LeRoy Abbott and his co-workers (1947). As the result of intensive animal experimentation and clinical studies he was able to show that the cortical graft such as Albee used possessed " strength but little osteogenetic power." On the other hand cancellous bone, because of its loose structure and the presence of numerous endosteal cells, possesses a high osteogenetic power and permits of early and thorough revascularization. Cortical bone may be used to advantage with cancellous bone which furnishes the osteogenetic medium. Cancellous bone possesses a high degree of vitality in the presence of infection, particularly if penicillin is employed before and after the operation.

SURGERY OF POLIOMYELITIS AND OTHER FORMS OF FLACCID PARALYSIS

Although orthopaedic interest had attached to the treatment of poliomyelitis from the earliest days of the Association, and important articles had been published by Goldthwait, Bradford, Dana and Townsend, Whitman, G. G. Davis and others, it was not until the extensive epidemic of 1916 and its pathetic harvest of crippled bodies that orthopaedic surgeons began to note the numerical increase of paralyzed patients in their clinics and in their office practice. At this time appeared Dr Robert Lovett's spring balance test for muscle strength which has added considerably to the accuracy of our methods of examination. He developed a series of exercises for paralytic cases which, with the aid of his physical therapist, Miss Wilhelmina Wright, have formed the basis of the system of so-called " muscle education." The publication in *Surgery, Gynecology and Obstetrics* of three articles dealing with the anatomy, physiology and surgery of tendons—a summary of the monograph by Biesalski and Mayer—stimulated more precise attention to the technique of that most valuable adjuvant in the correction of paralytic deformities—the transplantation of strong tendons to replace those of paralyzed muscles.

The operative treatment of poliomyelitis may be divided into:

1. The release or correction of contractures.
2. The stabilization of joints.
3. The re-establishment of muscle balance by tendon or fascial transplants.

To the first group belong such operations as: the lengthening of the Achilles tendon, best done by an open operation; the correction of knee flexion contracture by lengthening of the hamstring tendons or capsulotomy or osteotomy of the femur; correction of genu recurvatum by the ingenious operation of Gill (construction of a powerful posterior check ligament); the

release of flexion contracture of the hip by the Soutter or Campbell methods; correction of fixed obliquity of the pelvis (Mayer) by division of the tight quadratus femoris or other tight abductors or adductors and application of a push-pull device; the improvement of paralytic scoliosis by the turnbuckle plaster (Hibbs and Risser); and release of tight posterior capsule of the carpo-metacarpal joint of the thumb.

The second group, stabilization of joints, includes the following:

At the foot—The astragalectomy of Whitman for calcaneus; the G. G. Davis horizontal transverse section of the foot for cavus; the Hoke stabilization; the Ryerson triple arthrodesis; and, from across the waters, the Naughton Dunn and Lambrinudi operations. In flail foot pantalar arthrodesis may be indicated; occasionally the tenodesis of Gallie is effective. *At the knee*—The bone block operations for recurvatum of Campbell, Mayer and Milgram, or in rare instances fusion to eliminate the necessity of a brace. *At the hip*—Fusion for recurrent paralytic dislocation or for extensive paralysis of hip muscles with intact abdominal muscles; fusion of the spine; arthrodesis of the shoulder for extensive paralysis with good thoraco-scapular muscles: *At the wrist*—Fusion to stabilize the hand for the better function of the fingers: *In the hand*—Bone graft for paralyzed opposing muscles of the thumb.

To the third group belong the transplants of tendon and occasionally of fascia. Silk ligaments (Bartow and Plummer) and silk tendons (Lange) are no longer used. In all these operations certain rules must be observed. These are given in the section dealing with surgery of tendons.

The following are the more important tendon transplants:

At the foot—Shift of the peroneus longus to replace a paralyzed tibialis anterior alone (Peabody) or with the peroneus brevis to overcome drop foot; shift of the tibialis anterior alone or with extensor longus hallucis, to the outer side of the foot for varus; shift of the peronei and the tibialis posterior, or the flexor longus hallucis, to the insertion of the Achilles tendon for paralysis of the triceps surae; transplantation of the tibialis anterior to the Achilles tendon through the interosseous membrane (Peabody); transplantation of the tibialis posterior through the interosseous membrane to the outer side of the foot for equinovarus. Both these latter operations require particular care to avoid adhesion of the tendon as it passes through the interosseous membrane.

At the knee—Transplantation of the biceps femoris, usually with one of the inner hamstrings (preferably the sartorius) to the patella, for paralyzed quadriceps.

At the hip—The Ober or Mayer transplants of fascia to strengthen a weak gluteus maximus through the action of the erector spinae; the T. C. Thompson transplant of the abdominal muscles to strengthen the abductors; and the Telson forward shift of the gluteus maximus to aid abduction.

For paralysis of the abdominal muscles—The fascial transplants of Lowman, or the Mayer modification of his method by attaching the fascial grafts to the rib above and to the ilium or Poupart's ligament below.

At the shoulder—The trapezius transplant (Mayer) and the triceps-biceps transplant (Ober) for weakness of abduction; the teres major transplant for paralysis of the serratus magnus; the L'Episcopo shift of the latissimus dorsi and teres major to the posterior surface of the humerus for weakness of the external rotators (usually combined with division of pectoralis major and subscapularis for internal rotation contracture).

At the elbow—For paralysis of the biceps and brachialis anterior the upward shift of the muscles springing from the medial condyle of the humerus and the coronoid process of the ulna (Steindler). This operation when correctly performed gives amazingly good power of elbow flexion. Attachment of the muscles is best made into the bone rather than by the original suture to the intermuscular septum.

At the wrist—Transplantation of the flexors carpi radialis and ulnaris, usually with the palmaris longus and the pronator radii teres, to the extensors of the wrist and fingers for drop

wrist and paralyzed finger extensors; transplantation of the extensors carpi radialis and ulnaris to the flexors of the fingers; the Bunnell operation for paralysis of the opposing muscles of the thumb (transplantation through a pulley at the level of the pisiform bone of a flexor tendon to the dorsum of the proximal phalanx of the thumb). This operation has been modified by J. C. Thompson and others, but the original Bunnell technique gives almost perfect restitution of function; the Bunnell operation for paralyzed interossei by transplanting the flexor sublimis digitorum to the tendons of the interossei (a delicate, exquisite operation); transplantation of extensor indicis proprius for paralysis of extensors of thumb or other fingers; and replacement of the pinching muscle (first dorsal interosseous) by one of several tendons.

This section, though dealing chiefly with the surgical treatment of poliomyelitis, would be incomplete without mention of the name Sister Elizabeth Kenny. When nursing in " the bush " of Australia many years ago she came face to face with the practical problem of treating fresh cases of paralysis. Far from any doctor, she was forced to use her own initiative and, remembering that as a little girl she had seen her mother relieve painful muscles by hot moist applications, she tried the same method on the paralyzed children. They liked it. The tender, sore muscles were soothed by the moist heat and by her skilful fingers. Muscle power happened to return. Thus encouraged, she began to treat more cases and soon established a local reputation which eventually extended to the entire continent and involved Nurse Kenny in a heated controversy with the Australian Medical Association. Though a medical investigating committee declared against the Kenny treatment, she, nothing daunted, came to America armed with such strong letters of recommendation that Mr Basil O'Connor, president of the National Association for Infantile Paralysis, felt impelled to give her a chance. His idea was to run two parallel wards in the Minneapolis General Hospital, one for the Kenny treatment, the other for the rather vague and uncertain "current treatment." Within a week, however, Sister Kenny had all the patients; for the parents insisted that their paralyzed children be treated by her. So she ran the two wards. She demonstrated to the satisfaction of Drs Cole and Pohl, who were there to observe her, that every case of acute infantile paralysis showed definite spastic components; that this spasm could usually be relieved by the moist packs; and that as the spasm receded the opposing muscles in many cases regained power. Even respiratory paralysis was treated by hot packs without the use of the Drinker respirator and without tracheotomy, and some very severe cases recovered. The National Foundation was sufficiently impressed to set up instructional courses; physical therapists from every state came to Minneapolis to study the Kenny treatment. Doctors came too. Some, like Hibbs of Texas, became advocates; others like McCarroll of St Louis, bitter opponents. He and Albert Key maintained that whatever was good in the Kenny technique had been used before; that whatever was new was invalid. They accused Nurse Kenny of wishful thinking, incorrect observations and misrepresentation.

Despite the fact that moist heat had been used in the Children's Hospital of Boston in the early years of the century, and that isolated observations of spasticity in poliomyelitis had been noted, Sister Kenny must be given credit first for emphasizing the great value of moist heat as an important phase of treatment, secondly for starting treatment at once instead of waiting till tenderness had disappeared, and thirdly for insisting on the presence of spasticity in the paralyzed muscles. Above all she stimulated interest in the treatment of the acute stage of the disease. Though rejected by most orthopaedic surgeons, her method was accepted and practised in some of the foremost pediatric clinics and in the municipal isolation hospitals. She preached much that in this writer's opinion was unsound, but she had a natural talent for nursing, a compelling personality which attracted even the youngest of her patients, great patience and untiring energy. She thought nothing of spending the entire night applying Kenny packs to a sick child. Her method of muscle re-education, though open to theoretical criticism, gave good practical results in many children who were made to concentrate much more effectively by Kenny than by reciting sing-song verses as in some orthopaedic clinics.

Opinion still remains divided. Dr Pohl's (1947) article in this Journal and his monograph, *The Kenny Concept of Infantile Paralysis* (1943) are a good defence of the method; the report of the orthopaedic investigating committee condemned it. It is, however, still being used very extensively. It has stimulated research such as that of Plato Schwartz, and the use of pharmaceutical relaxants such as curare (Ransohoff) which have apparently been helpful. Careful unbiased observation over many years should be the method of reaching a final conclusion.

RECURRENT DISLOCATION OF THE SHOULDER

JESSE T. NICHOLSON, PHILADELPHIA, PENNSYLVANIA

In the past twenty-five years the operative treatment of recurrent dislocation of the shoulder has been, with a single exception, intracapsular. The previously devised extra-articular procedures denoted surgeons' reverence for joint space and their fear of initiating a pyoarthritis. Due to the prolonged insistence upon extra-articular trials of capsular reefing, bone blocks, muscle transplants, tendon shortening and tendon lengthening, the intra-articular pathology was disregarded. It was Bankart in 1923 and Hill and Sacks in 1940 who recalled the forgotten intra-articular pathology. The latter authors revealed by roentgen films the depressed defect in the posterior surface of the humeral head. This finding had been described as early as 1861 by Flower. Again in 1890 Broca and Hartman described the defect and, in addition, the torn anterior joint capsule, the stripping of periosteum from the neck of the scapula and " Bankart's lesion," the torn glenoid labrum. A few pertinent observations have recently been made. Fahey and De Cosola found, among fifty shoulder dislocations produced at autopsy, capsular tears from the neck of the humerus in 80 per cent and various types of glenoid labrum tears in the remaining 20 per cent. De Palma, Bennett and Callery revealed in cadaver dissections that sulci in the capsule between the gleno-humeral ligaments frequently communicated with the space between the subscapularis and the glenoid neck, and that there were frequently detachments of the glenoid labrum. Grant substantiated the latter finding. Gallie and LeMesurier pointed to variation in the shape of the glenoid in dry anatomical specimens. They suggested that anatomical variations were further substantiated by the frequency of bilateral involvement and by the occurrence of recurrent dislocations in two pairs of twins and three pairs of brothers.

Although Bankart described his operation in 1923 it remained practically unnoticed. For the great majority of surgeons, the intra-articular repair of recurrent dislocations began with Nicola's (1929) operation. This ingenious procedure, based upon the conversion of the long biceps tendon into a ligamentum teres for the humeral head, was relatively easily mastered. It was effective in a majority of subjects but owing to recurrences in those subjected to severe physical strain it began to lose its popularity prior to World War II. Bankart published his results in 1938, but it was Bost and Inman reporting their success with the Bankart operation in 1942 that sponsored its reception in America. A few years later surgeons reported failure to find the " Bankart lesion " in every case. The Magnuson-Stack procedure of transplanting the tendon attachment of the subscapularis muscle to the greater tuberosity to check external rotation was utilized after its publication in 1943. From England, however, came a surge of enthusiasm, based upon experience among military personnel, for the Putti-Platt procedure. Putti reputedly was doing the operation in 1923 and Platt independently developed it in 1925 but in either case their procedure was described by an associate (Osmond-Clarke 1948). The operation was technically easier than the Bankart. Although the exposure of the joint was the same the result of the operation did not depend upon finding a torn labrum glenoidale. The principle of the Putti-Platt operation was to sew the distal part of the divided subscapularis muscle to the labrum, periosteum and deep capsule in front of the neck of the scapula. The capsule was then sewn over it and the proximal part of the subscapularis sewn over all. This not only reinforced the anterior capsule but advantageously limited the

external rotation of the shoulder. Adams, in reviewing the three procedures, found recurrences after operation: Nicola, fifty-nine cases—twenty-one recurrences; Bankart, eighteen cases—one recurrence; Putti-Platt, thirty-seven cases—two recurrences. The average range of external rotation of the shoulder was eleven degrees less following the Putti-Platt as compared with the Bankart operation.

A few in America and a majority in the Scandinavian countries have developed enthusiasm for an anterior bone block on the rim of the glenoid—the Hybbinette-Eden operation. Ivar Palmer emphasized the effectiveness of the bone block in preventing the depressed defect in the posterior humeral head from slipping over the glenoid rim when the shoulder is externally rotated. He reported in 128 cases a post-operative recurrence in eight. This was better than that reported by Arno V. Hellens with twenty-five recurrences in 166 post-operative cases. Little information was given by the authors as to the limitation of shoulder motion after the bone block procedure.

Gallie and Le Mesurier reported upon the use of a fascia lata transplant through drill holes in the neck of the scapula, humeral head and coracoid. This reinforced the anterior ligament and checked the external rotation about twenty-five degrees. Though this method has had little recognition beyond Toronto since 1926, the authors have acquired 175 post-operative results with but seven recurrences of dislocation.

It is to be presumed that the effectiveness of the Hybbinette-Eden operation is based, as in the Putti-Platt and Gallie operations, upon checking the shoulder motion before it reaches its unstable position of external rotation, extension and abduction. These effective results obtained with such great effort on the part of the surgeon are similar to what Hippocrates accomplished two thousand years ago quite simply by applying a cautery to the axillary region.

CONGENITAL DISLOCATION OF THE HIP

The importance of this topic in orthopaedic surgery is indicated by the large number of articles and by the symposia of the American Orthopaedic Association devoted to it. Its historical development is of particular interest because of the swings of the pendulum, first toward the side of "bloodless reduction," then to open operation, then back to the closed method, then to open operation, finally to a combination of the two. At each swing the momentum was so great as to carry most orthopaedic surgeons off their feet; only a few rugged individualists managed to keep their balance. Only recently, largely through the courageous exposition by Bruce Gill of the heavy percentage of poor end-results, by the pathological and embryological studies of Vernon L. Hart and Carl Badgley, by the differentiation of types of displacement by McCarroll and Crego, and by improved operative techniques (Colonna, Howorth, Gill, McCarroll and Crego) has light begun to dawn.

When the manipulative correction of congenital dislocation was first reported by Paci in 1887 a wave of enthusiasm swept through the orthopaedic ranks. This was a real triumph for the new speciality: but not for long. Soon both Hoffa and Lorenz condemned the closed reduction and urged open operation. Lorenz claimed excellent results in a series of 100 cases. Hoffa also was pleased with his results, but there is presumptive evidence of wishful thinking on his part as shown by the remark of a famous contemporary surgeon: "Before operation Hoffa's patients walk like ducks; after operation they walk like operated ducks." Within three years Lorenz switched to the closed method and urged it strongly in his address before the American Orthopaedic Association in 1896. Bradford in his exhaustive paper of 1900 stated that both the open and closed methods lacked precision; he favored the open operation which gave six good results out of nine, whereas all his closed reductions redislocated. This he attributed to anteversion, and suggested a rotation osteotomy of the femur as a cure. But later, like Lorenz, he returned to the closed method and developed a special "reduction table" which Lange of Munich admired so much that he took one home with him after his American trip of 1910.

Sherman was not satisfied with the results of closed reduction. G. G. Davis considered the Lorenz method too traumatic and developed his own technique (1906) by posterior pressure on the trochanter. Most surgeons adhered to the Lorenz technique, but in 1920 a bombshell was dropped by Herbert P. Galloway of Winnipeg who stated that the closed method was " blind, irrational and deplorably uncertain in results." He advised open operation in all cases. In his first series of thirty-eight hips he secured good results in twenty-six; in his second, published in 1926—also thirty-eight hips—he secured thirty-three good repositions. In 1926 Farrell, von Lackum and Smith, reporting the series at the New York Orthopaedic Hospital, found that by the closed method of Hibbs only 39 per cent remained reduced. Because of anteversion, rotation osteotomies were done in thirty-five patients.

At the symposium of 1935 Freiberg urged earlier recognition and greater proficiency—that is, gentleness—in reduction. The indication for open operation was the failure of the closed method. Steele Stewart gave a beautiful embryological demonstration. " The pathology of congenital deformity is," he said, " sown in heredity, develops in embryo and fruits under the trade winds of use." The open operation is necessary to obliterate the fold of the capsule which prevents satisfactory replacement. He, too, stressed the importance of anteversion. Wallace Cole and Fred Kidner both favored the open operation. Farrell and Howorth in a comparative series reported 42 per cent successes by the closed reduction, 77 per cent by the open. Four papers (Dickson, Gill, Phemister and Compere, Ober) were devoted to the construction of a " shelf " to deepen the aplastic acetabulum, or to support a dislocated head. Of these, Gill's was unusually instructive both because of his refined surgical technique and his careful analysis of the types of pathology which require variations in the operative procedure. Gill concluded with the optimistic statement: " Judicious combination of closed and open methods should give almost 100 per cent successful results in young children."

Gill's paper the following year was one of the most thorough and convincing in the literature. His treatment may be summarized as: reduction in infants by simple abduction; in young children (two to three years) by gentle manipulation; removal of plaster in four months; if redislocation occurs, deepen acetabulum by shelf operation preferably without opening the capsule. He praised Putti's educational program for the early recognition of congenital dislocation as the most important recent development in the treatment of the condition.

In 1936 Kleinberg wrote an excellent short paper on the inadequacy of the acetabulum, and coined the phrase " acetabular index " to indicate the degree of obliquity of the roof. Ponseti's article (1946) on pathomechanics of the hip after shelf operations brought out clearly the importance of the comparative length of the horizontal distance between the mid-line of the body and the replaced head—the longer the distance, the less favorable the supporting action of the femur and its abduction mechanism.

Of particular significance is the symposium of 1948. In this, as in his paper of 1943, Gill stressed the inherent difficulties which face the orthopaedic surgeon. " The form and the degree of the dysplasia of the various structures of the hip joint which is present at birth, and the ability or inability of resumption and continuation of normal growth after reduction, are the essential factors that determine the end-result." After a careful follow-up of 105 cases he concluded that one could expect the following: 25 per cent perfect results after closed reduction —35 per cent if during the first three years of life; 15 per cent more of satisfactory results—or 20 per cent in children under four years of age; failure in 60 per cent—or in 45 per cent in the younger group. Open operations and shelves are helpful, but perfect results are found only in " cases amenable to bloodless reduction."

Similar end-results were reported by Bost and his associates, except that they found a much higher percentage of perfect repositions in children treated during the first two years. Even as early as in the third year, the percentage of perfect anatomical and functional cures dropped sharply. As an overall figure, they estimated 74 per cent as functionally satisfactory.

In 52 per cent of their cases, however, they found aseptic necrosis: this was as low as 12 per cent in infants whose hips were reduced by simple abduction, but as high as 74 per cent when manipulation was necessary.

The most encouraging statistics come from the Shriners' Hospital for Crippled Children, St Louis, where in a series of seventy-eight cases of posterior dislocation with a follow-up period of one to fifteen years, Crego and Schwartzman secured forty-eight normal or " near normal " hips, twenty-four satisfactory, and only six failures. In their work they have never used forcible manipulation nor the Lorenz " frog " position for immobilization. All cases were treated by preliminary traction, usually skeletal, until the femoral heads could be reduced by gentle pressure. If a " stable seating " in abduction and internal rotation was impossible—which occurred in twenty-five of the seventy-eight cases—open reduction with removal of the redundant part of the capsule was undertaken. This was supplemented by a " shelf " in forty cases with good results, even in children under five years of age. If careful analysis by X-ray studies showed excessive anteversion, a derotational osteotomy was done (sixty-seven operations) the upper fragment being held in internal rotation by incorporating a threaded wire in the plaster. Failure to correct anteversion results, they believe, in redislocation into an anterior position.

McCarroll working in the same hospital reported on primary anterior dislocation which in a series of 111 congenital dislocations " was encountered in twenty-five hips." These are much more difficult to treat: in five a successful closed reduction was accomplished with good result, in twelve a massive anterior shelf, and in four a superior shelf gave eight fair results and two good; there were seven results classed as poor.

It is evident that despite progress, orthopaedic surgery still has much to learn about the treatment of this congenital deformity.

CONTROL OF BONE LENGTH

WALTER BLOUNT, MILWAUKEE, WISCONSIN

[Equalization of leg length has appealed to the orthopaedic imagination for many years. As early as 1903 Codivilla reported his ingenious method of lengthening a femur by osteotomy and skeletal traction applied by a nail through the os calcis. Since then many papers have appeared dealing with this topic—among others, those of R. T. Taylor (1916), Calvé (1918), Putti (1921), Abbott (1927) and Warren White. A new principle introduced by Phemister has recently been modified ingeniously by Walter Blount, the author of this section. His report on " Control of Bone Growth by Epiphysial Stapling " has created great interest. The operation is being carried out in many clinics and in due course we may expect further clarification by follow-up studies—L. M.]

Before 1932 adjustment of the length of bones was by osteotomy and one-stage shortening of the long bone or lengthening of the short bone by the traction procedures of Putti, Abbott and others. Recently the use of sliding internal fixation by McCarroll's technique has renewed interest in femoral lengthening. In general, bone lengthening is a hazardous procedure, painful to both the patient and the surgeon. As pointed out by Warren White, leg shortening is a much more direct approach to the problem but has the constant objection of shortening the good limb. The hazard of non-union and infection is not as great as with bone lengthening but the operation is one of considerable magnitude.

In 1932 Phemister reported the arrest of longitudinal growth of bone by a new method. He curetted and grafted one epiphysis of the long bone at a time calculated to be suitable according to growth charts. The operation was of less magnitude and it did not carry as much risk of complication as the previous operations. Failure to stop growth on one side of the bone occasionally resulted in angular deformity. Mistakes in calculation of the expected growth resulted in inadequate or excessive correction, although these errors have been diminished by the accurate studies of Abbott (1927) and Green (1947).

Stimulation of growth by sympathectomy has long been popular in Canada (Harris). It is unpredictable but is usually insufficient to be of practical value unless there is definite clinical evidence of circulatory embarrassment. Stimulation of growth by juxta-epiphysial bone operations of various types usually achieves so little increase in length that it is not practical. If osteotomy or osteoclasis is indicated for another reason (angular deformity) it may be counted on to stimulate some temporary increased rate of growth, particularly if it is repeated. Recently Pease has implanted various foreign materials in the metaphysis, and advocates the use of ivory screws to stimulate growth.

While looking for a method of stimulating growth in 1945, Haas discovered that growth of an epiphysial plate could be retarded by encircling it with a wire loop. This proved feasible in laboratory animals and in children. Growth was held back mechanically. When the wire loop broke or was removed growth was resumed at about the normal rate. The implications were tremendous. If the method could be made practical it would be unnecessary to compute the anticipated growth accurately. Temporary retardation was vastly superior to permanent arrest.

Stimulated by Haas, in 1949 Blount and Clarke reported their work in the practical use of rigid staples of the type which had been popularized by Burns. They proved that three stainless steel staples on either side of the bone would almost completely stop the growth of an epiphysial plate in an eight-year-old child. They proved also that upon removal of these staples two or three years later, bone growth would be resumed at about the normal rate. Simultaneously, Barr and his co-workers experimented with roentgen ray retardation of epiphysial growth but discarded it as impractical.

LOW BACK PAIN AND SCIATICA

JOSEPH BARR, BOSTON, MASSACHUSETTS

[From the layman's point of view no orthopaedic problem concerns him more realistically than backache. To a group of Boston's orthopaedic surgeons—Goldthwait, Painter, Osgood, Bucholz and Swaim—we are indebted for studies which transformed this vast limbo known as "lumbago" into a field of anatomically based differential diagnoses. To their early pioneer work no one has made a more significant recent contribution than another Boston surgeon, Joseph Barr, the author of this section—L. M.]

"As a rule, it [sciatica] is an obstinate affection, lasting for months or even, with slight remissions, for years. Relapses are not uncommon, and the disease may be relieved in one nerve only to appear in the other. In the severer forms, the patient is bedridden, and such cases prove among the most distressing and trying which the physician is called upon to treat."—Osler.

Although there are still large gaps in our knowledge of the causes and cure of low back and sciatic pain it is comforting to know that now in most cases, we can arrive at an accurate diagnosis and prescribe adequate treatment. Fifty years ago the *uncommon* causes of symptoms were well known and carefully described. Tumors, tuberculosis, syphilis, gout were recognised as etiologic agents, but there was little knowledge of the *common* causes such as disk lesions, mechanical instability and spondylolisthesis. Treatment fifty years ago was empiric—fantastically so—leeches, cupping, purging and acupuncture were commonly used for sciatica, which was thought to be a primary neuritis.

It is easy to single out certain major contributors who have revolutionized our concepts of diagnosis and treatment but let us here pay tribute to the many others who have also contributed their modest bit. The discovery of the Roentgen ray gave little immediate help in diagnosis as the early apparatus was not sufficiently powerful to penetrate the heavy structures of the low back. Better X-ray tubes and the invention of the Bucky diaphragm made it possible to obtain films of fair diagnostic quality by 1920, and of good quality by 1935. The development of contrast myelography added another important laboratory diagnostic aid.

Pioneer work in directing attention to the lumbo-sacral spine and its articular facets was contributed by Goldthwait, Hibbs and Putti. They pointed out the possibility of mechanical strain and arthritis of these structures producing low back and sciatic pain. Other investigators laid stress on the role of the sacro-iliac joints, articulating transverse processes, tight fascial structures, tender trigger points and spasm of the pyriformis as etiologic factors. Almost all authors felt that the common syndrome of low back pain and sciatica was due to mechanical strain with secondary " reflex " pain. There was little agreement on the location of the exact structures involved or on proper methods of treatment.

Practical techniques of spine fusion developed by Hibbs and Albee in 1911 were first used for tuberculosis and scoliosis, but were soon applied to the treatment of lumbo-sacral strain. Sacro-iliac arthrodesis, fascial stripping, fasciotomy, pyriformis section, excision of articulating transverse processes were other operative approaches to the problem in common use between 1920 and 1935. Non-operative techniques were too numerous to mention. The lack of agreement on methods of treatment obviously stemmed from ignorance of etiology and failure to appreciate the fact that there is a natural tendency to spontaneous remission of symptoms. Nevertheless these pioneers have shown that mechanical strain is a factor to be reckoned with, and that stabilization by fusion is a potent therapeutic weapon.

The recognition of the etiologic role of intervertebral disk lesions has occurred within the past twenty years. The neurologist, neurosurgeon, roentgenologist and orthopaedic surgeon as well as the suffering patient share an intense interest in this relatively new concept. Schmorl's fundamental studies on the intervertebral disk, confirmed by Beadle, Mauric, Keyes and Compere and others focused attention on this structure. Clinical case reports by Elsberg, Kocher, Middleton and Teacher, Goldthwait, Dandy, Bucy, Alajouanine and Petit-Dutaillis suggested that disk lesions occasionally produced nerve root compression. In 1934 Mixter and Barr reported a series of nineteen cases as " Rupture of the Intervertebral Disk with Involvement of the Spinal Canal." Their series included cervical as well as lumbar lesions. In 1937 forty cases of proven disk protrusions including only lumbar lesions were reported from the Massachusetts General Hospital. It was pointed out that the symptoms and signs of a disk lesion are indistinguishable from so-called lumbo-sacral or sacro-iliac strain. A recognizable clinical syndrome was described and local nerve root pressure due to disk protrusion was established as a cause of backache and sciatica. " It is not excessively rare and should be thought of in every case of back strain and sciatica."

There was at first considerable scepticism regarding the significance of disk protrusions but the concept gained ground rapidly. Thousands of cases proven by operation have been reported by many different clinics. Friberg, Hirsch and others have shown that degenerative disk change normally occurs with increasing age and may be accompanied by mechanical instability of the spine. This is an important concept and is subject to demonstrable proof as shown by examination of spine specimens removed at autopsy, and in the living, by X-ray examination with the spine flexed and extended. It is becoming evident that backache is often associated with the mechanical instability of a degenerative disk lesion.

There have been marked technical advances in the operative treatment of disk lesions. Careful analysis of the clinical findings supplemented by diagnostic myelography permits accurate localization of the lesion in most cases. Special instruments and highly perfected surgical skill in exposure and technique have made the operation for removal of a protruded disk a very precise one. In most cases dramatic relief of sciatic pain may be confidently expected after excision of the protruded disk fragment.

End-result studies, however, show that backache and other residual symptoms and signs may be found in some of these cases. Surgical fusion of the vertebrae adjacent to the involved disk has been proposed as a method of overcoming these residual symptoms and some surgeons perform fusion as a routine measure. Others oppose this, reserving fusion for patients not satisfactorily relieved by simple removal of the protruded disk.

This quick backward glance over a few of the advances made in the solution of the problems of low back and sciatic pain should be heartening to all who deal with them. Scientific inquiry yields its fruits to the curious, intelligent, diligent student. The " back-trees " are still laden.

IDIOPATHIC SCOLIOSIS

Reference has already been made in Part III to the treatment by E. G. Abbott (1917). His papers demonstrated the roentgenological correction of severe rotary curvature, but the method had to be abandoned because the forces used were so great as to cause extensive decubiti and secondary malformations worse than the pre-existing scoliosis. In 1914 Hibbs performed the first fusion operation for scoliosis and in 1924 was able to report the results in fifty-nine cases. Correction was usually secured by traction and application of plaster-of-paris corsets, in some instances by the " wedging " or turnbuckle jackets. He concluded that " we have in fusion a means of preventing the progress of deformity of scoliosis in cases in which it is caused by muscle unbalance." In 1922 Kleinberg modified the Hibbs technique by adding a strong beef-bone graft and in 1927 Armitage Whitman utilized portions of the resected prominent ribs as reinforcement of the fusion area. Proof of the efficacy of fusion was demonstrated by Alan de Forest Smith (1923) who in nine reoperations on spines fused by the Hibbs method found the laminae united by a solid sheet of bone.

In 1931 appeared a paper by Hibbs, Risser and Ferguson, significant for six reasons: 1) the mathematical determination by measurements on the X-ray film of the angle of curvature; 2) the perfected use of the hinged anterior-posterior turnbuckle jacket as developed by Risser; 3) an improved operative technique by which the area to be fused was accurately determined by means of markers; 4) the performance of the operation through a large window cut in the plaster; 5) the reduction of mortality in a series of 427 operations to 1·6 per cent; 6) proof that fusion can prevent advance of the curve, and in some cases maintain the correction secured by the turnbuckle plaster corset. The repercussions of this article were so great that for more than a decade the Hibbs-Risser-Ferguson method dominated the treatment of scoliosis. The report of the Research Committee of the American Orthopaedic Association in 1941 concluded as follows:

1. Practically none of the patients with scoliosis are cured, if correction of lateral deviation is a criterion.

2. In approximately 60 per cent of those treated by exercises the deformity increased and in 40 per cent it remained unchanged.

3. Correction without fusion resulted in complete loss of correction after support was discontinued, in the majority of instances.

4. Correction by the turnbuckle jacket and subsequent fusion has yielded better results in this series than have other types of treatment.

The results in 69 per cent of the cases were rated as fair or poor, and 31 per cent good or excellent.

The high percentage of poor results caused some careful students to begin to have their doubts about the wisdom of the method. They reconsidered Steindler's teaching (1929) that the " treatment of scoliosis is not only a problem of orthopaedic surgery, but also of orthopaedic reconstruction," that maintenance of correction is not necessarily " best solved by totally abolishing the mobility of the spine, in other words, by operative fusion." Steindler's emphasis on " compensation " began to take on added meaning when follow-up studies of cases fused in correction by the development of extreme counter curves above and below the fused area could not compensate—that is, assume the upright posture—without a pseudarthrosis in the fusion area or by a gradual giving-way of the fusion.

This more critical attitude was well expressed in 1949 by a member of the New York Orthopaedic Hospital Staff, Dr Wm. H. von Lackum. He conceded that the follow-up of

operative cases had revealed many instances of what he euphemistically called " substandard results." These were due, he thought, to excessive correction, since the maximum amount of compensatory adjustment of the secondary curves amounted to only twenty degrees. Therefore any correction beyond this degree caused a lack of compensation.

In the same year (1949) Dr John Cobb presented a unique paper (not yet published) backed up by an exhibit at the Chicago meeting of the American Academy of Orthopaedic Surgeons, in which on the basis of more than 3,000 cases observed over a period of four or five years he concluded that the vast majority of scolioses do not progress beyond a certain fixed point which can be determined by systematic roentgenographic examination; that in this large group—95 per cent of the idiopathic cases—no treatment is necessary other than a rest period after school hours and good general hygiene; that braces and spinal exercises have no demonstrable beneficial effect; that in the 5 per cent of cases which show a tendency to advance beyond the mild stage fusion can be successfully used after correction in the turnbuckle jacket. Cobb advised a one-stage operation with the use of banked-bone, and a long post-operative recumbency period until the callus had become thoroughly organized (six to nine months). His demonstration of results was most convincing.

Another significant contribution was by Blount and Schmidt who at the 1948 meeting of the Academy exhibited a turnbuckle extension brace which could be applied before operation; and after operation, during the period of maximum correctibility of the curve, it could be adjusted so as to secure a gratifying degree of improvement. Their results have not yet been published in final form.

Papers dealing with the theory of scoliosis by Farkas (1941) and by Arkin (1949) add to the fascination of this problem, which, though still unsolved, has unquestionably shown signs of yielding to the steady attack of progressive orthopaedic surgeons.

FRACTURES OF THE NECK OF THE FEMUR

[In preparing this and the following section I have been greatly helped by my office associate, Dr Barnard Kleiger, associate attending surgeon of the Hospital for Joint Diseases.]

During the early years of the American Orthopaedic Association fractures were scarcely mentioned. The first indications of orthopaedic interest were in 1892 when John Ridlon in conjunction with Robert Jones reported twelve cases of fracture of the femoral neck treated by the Thomas hip-splint, and in 1893 when Whitman published the first of his two papers dealing with fracture of the neck of the femur in children. In 1894 Ansel Cook wrote a brief article on "Fixation in the Treatment of Fractures into Joints." In 1897 appeared additional papers by Ridlon and Whitman and a contribution by Newton Shaffer entitled "On the Mechanical Treatment of Ununited Fractures of the Neck of the Femur with Traction Apparatus Producing Abduction of the Thigh and Direct Lateral Pressure Over the Trochanter Margin." The ideas of Ridlon and Shaffer have passed into oblivion but Whitman formulated the germ of an important principle. Though unable to treat any one of the ten cases observed, since in none had the diagnosis been made at the time of injury, he wrote that reduction in such fractures could " best be accomplished by abducting the leg its full limit; thus by leverage of the rim of the acetabulum and by downward pressure on the trochanter with extension of the limb, one might hope to rectify the deformity, at least in part." This idea, elaborated in his paper of 1902 dealing with adult femoral neck fractures, dominated the thinking both of general surgeons and orthopaedists, until 1932 when Dr Guy Leadbetter made an important modification of the method of reduction by flexing the thigh before abducting. He, like Whitman, continued to use the plaster-of-paris spica as the best means of fixation. In 1938 he was able to report 71 per cent of unions in fifty-nine patients treated by this method.

The importance of Whitman's contribution cannot be overestimated: he demonstrated

that the orthopaedic surgeon could secure better results in the treatment of this difficult fracture than the general surgeon, and thus created the entering wedge which gradually has shifted the responsibility for fracture treatment from the general to the orthopaedic surgeon.

Smith-Petersen in 1931 revolutionized the treatment of femoral neck fractures when he introduced the three-flanged nail for internal fixation of the fracture after open reduction. Subsequent improvements in roentgen control of closed reduction and accurate insertion of a nail of the proper length permitted elimination of a hip arthrotomy for open reduction. Among the many workers each of whom contributed something to the development of this operation were White, Wescott, Plummer, Sloat and Peterson, King, O'Meara, Cox and Cotton.

Subsequently the Smith-Petersen nail was modified by Johansson of Sweden to include a central cannula. This permitted more accurate insertion of the nail over a guide wire. Many other appliances have since been devised for internal fixation of femoral neck fractures but none have replaced the Smith-Petersen nail in popularity. Among these are the threaded steel wires proposed by Moore (1934) and by Telson and Ransohoff (1935). These were modified by Knowles (1936) who added a fixed head instead of threaded nuts. Gaenslen in 1935 advocated the use of several spikes to fix the femoral head. Compression bolts and lag screws were devised by Melville Henderson, Henry, Lippmann and others.

Internal fixation immobilized the fracture adequately and permitted bone healing to take place as demonstrated by Kulowski and Luck in 1941. Though the fracture healed, however, the follow-up study of Boyd and George in 1946 indicated that other dangers lurk in the path of a good result. These authors reported a follow-up study of 300 cases treated by internal fixation; 285 with the Smith-Petersen nail and fifteen with Knowles pins. Though 86·5 per cent of these cases united, yet they had only 43·6 per cent of good results without articular change; 19 per cent fair results with moderate articular change due to aseptic necrosis or moderate arthritis and 28·1 per cent poor results due to non-union, aseptic necrosis or severe arthritic change. The mortality rate was 9·3 per cent. These complications in the course of healing have been the subject of extensive studies by Phemister and Sherman who have found that they are caused by circulatory disturbances resulting in aseptic necrosis.

A report by the Fracture Committee of the American Academy of Orthopaedic Surgeons in 1941 also pointed out these dangers. Of 241 cases collected from various clinics throughout the country 144 had been treated by Smith-Petersen nails, eighty-three by wires and fourteen by miscellaneous methods of internal fixation. Union occurred in 70·1 per cent of the total number of cases. Further analysis showed that 72·9 per cent of those fixed with a Smith-Petersen nail united, 62·7 of those with wires and 85·7 per cent of those with miscellaneous apparatus. Of those that united with a Smith-Petersen nail, 73·4 per cent developed no arthritic change, 2·9 per cent Grade I arthritis, 4·7 per cent Grade II, 4·7 per cent Grade III and 14·3 per cent Grade IV. When wires were used, 71·2 per cent had no arthritic change, 9·6 per cent Grade I, 3·8 per cent Grade II, 1·9 per cent Grade III and 13·5 per cent Grade IV. The conclusion of this committee presents a timely and important warning. "In the hands of experienced surgeons the end-results obtained in fractures of the neck of the femur have been greatly improved by the use of internal fixation. When employed by the inexperienced or untrained the outcome is often deplorable and the end-results inferior to those seen following non-operative means."

These statistics do not adequately picture the advantages of internal fixation which free the patient from a long period of immobilization in plaster-of-paris and consequent stiffness of the knee as well as of the fractured hip.

OTHER FRACTURES

The physiological process of callus formation has been studied by Phemister, Key, Potts, Haldeman, Urist and McLean, Clay Ray Murray and others. In addition to the well-known facts regarding the invasion of the haematoma by capillaries, resulting in fibroplasia,

chondrification and eventually ossification, much has been learned about the causes of the initial fall and subsequent rise in the *p*H of the tissue fluids at the site of fracture, the influence of phosphatase, the nature of calcification and the local necrosis of the bone ends. Moot points are: 1) the origin of the osteoblastic cells—some maintaining with Macewen that they emanate from the bone, others from the periosteum, others from the endosteum, still others from a metaplasia of the surrounding connective tissue cells; 2) the influence of foreign bodies, such as metal plates, or the Küntscher nail on the production of callus; 3) the causes of non-union or delayed union.

The ideals of treatment remain to-day exactly as they were outlined by Sir Robert Jones many years ago—the restoration of function by the simplest, quickest and least dangerous method. Closed reduction and immobilization, either in a splint, as used by Hugh Owen Thomas and Robert Jones, or in plaster-of-paris, is probably the method of choice in the majority of cases. Most orthopaedic surgeons find it advisable to reduce the fracture as soon as possible, but a strong advocate of delay has been found in John R. Moore of Philadelphia. His method, which has been characterized as " the set 'em on Tuesday," has in his expert hands given excellent results in over 7,000 cases. His weekly clinic at the Temple University Orthopaedic Department, when he reduces and immobilizes fifty or sixty fractures in a morning is unique. It must be emphasized that he does not tolerate any delay when there are peripheral nerve or vascular complications, and that every fracture is given a preliminary immobilization in plaster-of-paris.

For fractures of the femur and some fractures of the humerus traction still retains its importance. The modern technique of so-called balanced traction was introduced by a general surgeon, Dr Joseph Blake, during the first world war. It represented a considerable improvement over the method of Bardenheuer of Cologne which had until then dominated the German, and even the American schools. Skin traction by adhesive strips has been largely replaced by skeletal traction; for the original Steinman pin has been substituted the Kirschner wire which rarely causes the persistent sinuses seen rather frequently when the Steinman nail was used. During the war traction by a Kirschner wire through the tibia was one of the accepted methods of treating fractures of the femur in military hospitals. A word must also be said about the ingenious traction method of Russell of Australia, which with slight modifications is most effective for femoral fractures with a tendency to anterior angulation. John Dunlop of Pasadena has demonstrated the value of traction in the transcondylar type of elbow fracture which cannot be held by the usual position of flexion advocated by Sir Robert Jones.

There are certain fractures which almost always require open reduction: these are the fractures of the patella and of the olecranon process with wide separation of the fragments. The latter can best be held by a screw, the former by an encircling suture if the fragments are of equal size and not comminuted; by resection of the distal fragment if it is small and comminuted. The patellar tendon is then reattached to the main proximal fragment. Occasionally, in very extensive comminution, the entire patella has to be removed.

The greatest strides in fracture treatment have occurred as the direct result of improved methods of internal fixation. The use of the metal bone-plate so vigorously championed in England by that most meticulous of surgeons, Sir Arbuthnot Lane, found equally ardent American champions first in Sherman of Pittsburgh, then in Clay Ray Murray of the College of Physicians and Surgeons in New York. The method has benefited greatly by technical advances in metallurgy. Through the researches of Venable and Stuck (1937) it was shown that the electrolytic currents set up by the implantation of the ordinary steel screws, resulting in bone absorption, could be completely eliminated by the use of inert metals such as an alloy of cobalt, chromium and molybdenum, known as vitallium. Later work by Key indicated that an equally inert alloy was the so-called 18/8 SMo steel (16 to 20 per cent chromium, 14 per cent nickel, 2·4 per cent molybdenum). This steel has the advantage that it can be

" cold-rolled," whereas vitallium must be cast. Further technical improvements resulted through the exact studies of Leonard Peterson (1947) of the Surgeon-General's office. Carried on in conjunction with an engineer, J. G. Collison, he was able to demonstrate that many screws did not hold because of the inaccuracy of their insertion. He devised a drill point of such a diameter as to permit the screw to grip the threads in the bone with maximum efficiency. A cruciate head to the screw, special guide to secure verticality and other aids to accurate insertion have greatly facilitated the technique of bone-plating.

The skilful work of William Darrach and Clay Ray Murray, and more recently of their successor at the Presbyterian Hospital, Dr H. L. McLaughlin, must also be stressed. Murray laid down precise rules which when followed gave a high percentage of healing with little stiffness of the adjacent joints: minimal trauma, careful aseptic technique, accurate length of screws, in oblique fractures the use of an additional screw so placed as to transfix the cortices of both fragments and thereby prevent rotation, early mobilization.

A contribution of great significance has recently been made by Dr Eggers (1948) of Galveston, Texas—the so-called " contact splint." This is based on the correct physiological premise that some necrosis of the fractured bone ends invariably occurs. To maintain contact of living bone to living bone, thus avoiding the danger of delayed union or pseudarthrosis, Eggers's plate has slots so placed that muscular contraction or body-weight will cause the fragments to remain in close approximation, despite the absorption due to necrosis. He has corroborated his clinical observations with a series of experiments on the healing of fractures of the rat's skull, so exquisitely performed that he was given an award for his exhibit at the meeting of the American Academy of Orthopaedic Surgeons in 1949. Eggers's work is in a way similar to Key's observation, subsequently elaborated by Charnley of England, on the beneficial effect of pressure in the healing of arthrodesed knees.

A form of intramedullary splinting was used in this country before World War II by Rush, but it never attracted attention until near the end of the war. Another type of intramedullary nail designed by a German surgeon, Küntscher, and very extensively used by Böhler of Vienna, was introduced into America by a number of German war prisoners and American soldiers operated on by this method in German hospitals. Soeur of Belgium (1946) helped to popularize the method by his thorough description in the *Journal of Bone and Joint Surgery*. The original nail of trefoil section has been modified by Hansen-Street who used a diamond-shaped nail. Whether this is better is still a moot question, but it is certain that the nail, whatever its shape, must be strong enough to resist lateral bending forces equivalent to the body-weight. Böhler, who at one time used the nail for almost all fractures, now with rare exceptions confines its use to the femur. It may be introduced " blind " through a small proximal incision above the trochanter, or by the open method, exposing the site of the fracture. The method is being employed much more extensively in this country, and with adequate experience in the technique the reported results are gratifying. All these methods of internal splinting have been rendered safer by the antibiotics.

An ingenious method of combining fixation with freedom of joint motion has been independently devised by three men—Haynes, Stader and Roger Anderson. They employ a splint which can be attached to the fractured bone by means of long pins which transfix one or both cortices. After manipulating the fragments into alignment the splint is " locked," thereby fixing the bone. Though good results are reported, the method was not accepted by the Surgeon-General's office, largely because of the danger of infection along the path of the pins, and the difficulty of application in the hands of any but the most experienced.

The use of bone grafts in fractures has already been described in the section dealing with bone grafting and the treatment of infected compound fractures in the section on osteomyelitis.

The necessity of thorough after-treatment emphasized by Sir Robert Jones more than thirty years ago is as true to-day as then. Every " fracture patient " must begin to use his muscles at the earliest possible moment. Every fracture service requires an experienced

physical therapist who will from the very outset work on the functional rehabilitation of the fractured limb. When healing has occurred strengthening of the muscles can be greatly aided by the De Lorme (1945) system of heavy resistance exercises.

SURGERY OF TENDONS AND OF THE HAND

Although Nicoladoni performed the first tendon transplantation in 1882 his contribution —like penicillin and many another good idea—lay dormant for many years. Then at the beginning of the twentieth century two orthopaedic surgeons in Germany, Vulpius and Lange, revived Nicoladoni's principle of replacing the tendon of a paralyzed muscle by shifting a strong tendon to take its place. Vulpius sutured tendon to tendon; Lange thought this method inadequate since the paralyzed tendon would stretch, and advocated instead a direct bony attachment. Since in many instances the transplanted tendons were too short to reach their destination he lengthened them with strands of strong silk soaked in paraffin and sublimate of mercury. His experience with this technique was the topic of his address before the American Orthopaedic Association in 1910, at which time he had already performed many hundred " silk tendon plastics." It was the author's good fortune to spend a year in Lange's clinic in Munich (1912–1913) where somewhat to his surprise he found that the results of the transplants were far from satisfactory. Lange was sufficiently objective to concede that something was wrong: he thought the difficulty was due to the formation of adhesions and therefore assigned as a research topic the problem of preventing post-operative adhesions. Together with Dr Carl Henze of New Haven the author performed an extensive series of animal experiments which proved conclusively that the one effective method of avoiding adhesions was the conservation of the normal gliding mechanism of the tendons (1914). This led a few years later (1916) to the publication with Professor Biesalski of Berlin of the monograph *Die Physiologische Sehnenverpflanzung* (The Physiological Method of Tendon Transplantation) which may be in part responsible for some of our advances in tendon surgery. A summary of the method was published in *Surgery, Gynecology and Obstetrics* in 1916.

In January of 1918 there appeared in the same journal a modest article by Dr Sterling Bunnell on the " Repair of Tendons in the Fingers." The significance of this contribution should be emphasized for it contained the germ of Bunnell's concept which was later elaborated into one of the most important surgical monographs of the century, *Surgery of the Hand*. He stressed in this paper four points: 1) an atraumatic technique; 2) lateral placement of the incisions with an L-shaped prolongation in the creases of the finger; 3) preservation of the pulleys; and 4) due regard for the gliding mechanism. Shortly thereafter the author met Dr Bunnell and worked with him; and the friendship then begun has ripened with the years. Bunnell's work combined with the anatomical-physiological observations of Biesalski and Mayer, and the practical teachings of Robert Jones, resulted in the formation of certain rules which apply to all types of tendon operations. The author has formulated these as follows:

" Since gliding is an essential function of the tendon, the operator must avoid damage to the gliding mechanism. An atraumatic technique must be cultivated. Never grasp the gliding surface of the tendon with mouse-tooth forceps, never allow the tendon to dry in the air, never wrap it in a piece of gauze even though the gauze be moistened, since any one of these procedures will damage the smooth surface cells. Grasp the tendon only where an adhesion is desirable, for instance, where it is to become attached to a bone; or where it is possible to remove that part of the tendon which has been traumatized by the clamp. Plan the operation so that the tendon will be exposed to the air for a minimal length of time and while it is exposed moisten it every minute or two with warm saline. The gliding pathway must be conserved. Do not damage the paratenon or the sheath. Wherever possible conserve the normal relationship between tendon and sheath. If the sheath has been destroyed strive to construct a new sheath which will replace the old. Avoid infection even of the mildest type by rigid

asepsis, for even a mild infection which does not produce suppuration may cause enough fibrosis to prevent gliding. Always restore the normal tension to the tendon operated on, for excessive tension produces muscle degeneration. Never forget that a transplanted tendon must obey the same mechanical rules as the normal tendon. Unless the line of traction is mechanically correct the tendon cannot do its work. Usually the course of a transplanted tendon should be straight, but if a sharp change of direction is necessary construct a pulley similar to that of the omohyoid muscle (Bunnell) or utilize the pulley action of the tendon sheath. Be careful to avoid injury to the main blood vessel of the tendon which is usually found running in the lower muscle fibres. The smaller vessels running in the mesotenon may, however, be divided with impunity. Always mobilize stiff joints before attempting a tendon operation since otherwise it will be impossible for the tendon to function. Repair divided nerves before suturing a tendon and replace dense scars by suitable skin transplants."

The most useful tendon transplants for the operative treatment of the residual paralyses of poliomyelitis have already been listed. These include important contributions by Frank Ober, Arthur Steindler, H. B. L'Episcopo, Charles Peabody, Schwartzman and Crego, and Charles Irwin. Ober (1935) has devised transplants of the long head of the triceps and of the biceps to strengthen a weak deltoid; he has also utilized the erector spinae muscle to reinforce a paralyzed gluteus maximus by running a fascial graft from the back muscles to the trochanter. Steindler's (1919) upward shift of the muscles springing from the medial condyle of the humerus to strengthen the weak elbow flexors has helped to restore function to many paralyzed arms. L'Episcopo's (1934) shift of the tendons of the latissimus dorsi and teres major to the posterior surface of the humerus, devised chiefly for obstetrical paralysis, gives excellent results. Charles Peabody (1938) made an exhaustive follow-up study of end-results and contributed a number of original ideas, such as the transfer of the tibialis anterior through the interosseous membrane to strengthen a weak Achilles tendon. Schwartzman and Crego (1948) studied 134 transplants of the hamstrings for quadriceps paralysis and concluded that the operation is of value, particularly if a medial muscle (the semitendinosus) is transplanted together with the biceps. Charles Irwin has divided the paralytic deformities of the thumb into a number of groups, for each of which an appropriate operation has been devised. In this he has been much helped by the previous work of Ney (1921), Lyle (1923), Steindler (1930), Royle (1938) and particularly Bunnell (1924 and 1938).

Meanwhile in paralyses due to trauma, particularly injuries of the radial nerve, successful results were secured by tendon transplants. One of the first papers, "Army Experiences with Tendon Transference," by Charles L. Starr (1922) was delivered before the British Orthopaedic Association. He reported fifty-two cases with excellent results in twenty-nine, good in fifteen, fair in seven, failure in one. Billington (1922) also found the operation most satisfactory. Twenty-four years later Altman and Trott (1946), using slight modifications of the same technique, working under the able direction of Dr Harry Blair, were able to report good results in all their twenty-eight cases.

In the surgery of the traumatized hand significant papers were written by Harmer (1922 and 1926), Auchincloss (1929), Garlock (1926), Koch and Mason (1933). The latter authors have given us a thorough report not only of the repair of tendons but also of the nerves of the hand.

Gratifying though these experiments have been, the culmination of surgery of the hand has been secured by Bunnell and his group of co-workers. Developing the essential concept of atraumatic technique first enunciated in his paper of 1918, Bunnell has applied this to every tissue of the hand—skin, fascia, tendons, muscles, nerves, bones and ligaments. He was the first to stress the importance of suture of the digital nerves, and suture of the motor branch of the median to the intrinsic thumb muscles; to develop adequate operations for paralysis of the opposing muscles of the thumb, for paralysis of the interossei, for restoration of "pinch." He has perfected the reconstruction of the thumb by pollicization of the index

finger. He has perfected the technique of tendon suture by one idea after another, the most recent being the so-called " pull-out stitch." He has applied bone grafts with the skill of an Albee, he has rivalled Gillies in the finesse of his skin grafts. He has devised scores of braces, so simple and inexpensive that they can be made by any mechanic with some wire and strips of felt. He has summarized his experiences in a book which the British tendon surgeon Furlong called his " bible," which is, as Boyes phrased it, " the vade mecum of all hand surgeons." It is significant of Bunnell's modesty that he himself is dissatisfied with the book and is now engaged in preparing a third edition so as to eliminate the many faults which he has noted in the first two editions. Best of all, his work has inspired a group of younger men to try to improve upon his methods: Littler, Luckey and MacPherson, Lott Howard, Boyes, Walter Graham and others are not content simply to follow in the master's footsteps but have already made notable contributions to aid in solving that most difficult of orthopaedic problems—the restoration of function to the crippled hand.

ADVANCES IN BIOCHEMISTRY AND RELATED FIELDS

The preceding sections have dealt almost altogether with advances in operative technique. The percentage of aseptic wound healing has been increased by the use first of the sulpha drugs, more recently by the antibiotics, but the influence of these biochemical developments has not been of paramount importance. Now we wish to review several fields of orthopaedic endeavor in which pharmacology, biochemistry, biophysics and other related sciences have been of much more significance. I refer particularly to osteomyelitis, tuberculosis, arthritis and abnormal neuromuscular disturbances such as cerebral palsy. Before considering them in detail, it will be helpful to take a general view of certain phases of scientific advance as seen through the eyes of a biochemist.

Scientific Progress

AARON BODANSKY, NEW YORK

Rapid advances in the chemistry of enzymes, vitamins and hormones have been made in the United States and Canada, particularly in the second quarter of this century. Spectacular developments in the field of antibiotics occurred in the 'forties.

Enzymes—The crystallization of highly purified urease by Sumner in 1926 must be noted, because it marked a new stage in enzyme research (the crystallization of this and other enzymes has so far not had wide clinical application).

Robison's work on yeast phosphatase was followed by his important studies on the role of alkaline phosphatase in bone formation. Kay noted increases of plasma alkaline phosphatase in bone disease. Development of improved analytical methods for the determination of alkaline phosphatase by Bodansky, and by King and Armstrong, permitted clinical studies on an adequate scale. Bodansky and Jaffe used this determination in studies of hyperparathyroidism, rickets, Paget's bone tumors and other bone diseases. Better evaluation of therapy in these diseases was likewise promoted by the use of this test.

After the demonstration of acid phosphatase in the prostate gland by Kutschner and Wolbergs in 1935, Guttman and his associates carried these studies forward to the demonstration of acid phosphatase in the serum of patients suffering from prostatic carcinoma with metastases to the bones. Huggins and his associates confirmed these findings and applied them in the now well-known treatment of prostatic carcinoma.

Vitamins—The existence of vitamin D and its role in calcium and phosphorus metabolism and the prevention of rickets in experimental animals was demonstrated by McCollum and associates. The effects of direct ultra-violet radiation in the prevention and cure of rickets and in the preparation of anti-rachitic substances were announced by Hess and Steenbock almost simultaneously.

Hormones—The development of purified insulin preparation by Banting, Best, Macleod and Collip has affected profoundly the treatment and course of diabetes, and has prevented or mitigated many of its complications. The development of purified parathormone by Collip permitted the production of experimental chronic hyperparathyroidism which was proven by Jaffe and Bodansky to be the experimental equivalent or analogue of clinical von Recklinghausen disease (osteitis fibrosa cystica). Chemical studies of the latter, including determinations of serum calcium, phosphorus and particularly of alkaline phosphatase activity, were performed by Bodansky and Jaffe before and after parathyroidectomy. More extended studies of the condition were carried on by Guttman and associates, Albright and associates and others. Such determinations have become standard aids in the treatment of clinical hyperparathyroidism.

Active research in the isolation, synthesis and study of the metabolic effects of female and male sex hormones has been carried on by many American investigators. The most striking demonstration of their relationship to bone pathology has been made in the control of prostatic cancer and of its metastases to the bone: orchidectomy and administration of female sex hormone by Huggins causes a remission of symptoms with the healing of bone lesions and the reduction of the acid phosphatase activity of the serum.

More recently ACTH was developed in the Armour Laboratories and cortisone was developed by Kendall and associates. The effectiveness of these substances in the treatment of rheumatoid arthritis and other conditions has been the subject of active research.

Chemotherapy and antibiotics—After the introduction of therapy by sulfonamides developed abroad, other derivatives were produced in this country. Their very wide application has been to some extent superseded by the more recent developments in the field of antibiotics. Dubos was one of the earliest American workers in this field. Selman Waxman has been among the foremost contributors; his many years of work in soil microbiology were appropriately climaxed by the preparation of streptomycin and other antibiotics.

Clinical Applications

OSTEOMYELITIS

No other field of orthopaedic surgery except arthritis owes as much to the recent advances in chemistry and bacteriology as does the treatment of osteomyelitis. We must of course differentiate in our thinking between: 1) acute haematogenous osteomyelitis—a generalized septicaemia with local bone manifestations; 2) chronic osteomyelitis—a sequel of the acute; and 3) localized traumatic osteomyelitis, with which the two world wars has made us all too familiar. The writings of Wilensky gave an excellent concept of the pathological process but did not help solve the therapeutic problem. Acute osteomyelitis was, until the advent of the sulfonamides (1935), a dread disease, particularly in children, with an estimated mortality irrespective of the method of treatment of 25 per cent. To-day, thanks to the antibiotics, the mortality is approximately 3 per cent.

We have already told in Part III of the treatment of infected gunshot fractures by Carrel during the first world war. Hawley of Bridgeport, who studied the method thoroughly, considered it one of the great surgical advances. He saw hundreds of infected compound fractures converted into healthy granulating wounds. He stressed the difficulty of carrying out the Carrel technique, which required daily dressings each the equivalent of a full-fledged operation. Meticulous débridement and the exposure of every portion of the wound to the action of the chlorine solution were essential to success. Probably for this reason, rather than because of an error in principle, the method lost popularity and was replaced by one directly opposed to it—the closed plaster treatment of Winnett Orr. Orr said " Leave the wound alone. Each time you touch it you stir up trouble." After débridement he packed the wound wide open with vaseline gauze, applied a closed plaster-of-paris dressing and allowed healing to occur undisturbed by the surgeon. The stench from the plasters was almost unbearable, but

healing occurred in a high percentage of patients. In 1935 this method was adopted by Trueta of Barcelona who, by adding sulfonamides to the dressing, increased its efficacy. Albee added bacteriophage but without any appreciable improvement.

An interesting phase of treatment was the use of maggots, introduced by Baer of Baltimore. Discovered accidentally, through contamination of a wound by the larvae of the blowfly, it unquestionably aided healing. Buchman used it for more than ten years with gratifying results and has stated, in a personal communication, that the beneficial action of the maggots was due to a combination of " subminimal physical irritation to produce granulations rapidly, enzymatic digestion of necrotic tissues, chemical inhibition of bacterial growths, bactericidal action and biological stimulation of tissue growth."

Attempts to improve therapy by bacteriophage (d'Herelle and MacNeil), antistreptococcus serum and staphylococcus toxoid proved unavailing, but in 1935 occurred a great discovery by Domagk—the therapeutic effect of the sulfonamides. Though this followed the work of Fleming, who in 1929 had observed the antibiotic effects of cultures of the fungus penicillin, it was the opening wedge in the therapeutic campaign. Soon the literature was flooded with reports of successful cases: Mitchell, Key, Hoyt, Davis and Van Beuren, Lennox Baker, Shands, Bick, Schnabel and Kuhn, Wilson and McKeever all wrote of the amazing effects of the " magic powder." Cases of acute osteomyelitis were cured without operation; in others no surgery was necessary other than incising a subperiosteal abscess.

Dickson, Diveley and Kiene (1941) reported twenty-two cases of subacute and chronic osteomyelitis in which they had secured good results with primary closure under sulfathiazole medication. Bick (1941) in his paper sounded a warning note with this concluding sentence: " In the treatment of haematogenous osteomyelitis sulfone chemotherapy is not a substitute for surgical judgment, operative technique or meticulous after-care." Some patients moreover were sensitive to the sulfa drugs, or failed to respond favorably. It was therefore not surprising that with the advent of the antibiotics, the first enthusiasm for the sulfonamides abated. Fleming's work in England had gone unnoticed for more than ten years when a group of Oxford investigators under Florey (1940) reviewed the study of penicillin, confirmed its therapeutic effect and developed purified penicillin suitable for clinical use.

In the United States the significance of penicillin was at once appreciated and its study was placed under control of the Committee on Medical Research of the Office of Scientific Research and Development. Thanks to the intensive work of numerous civilian investigators the clinical application of the antibiotic was perfected and the difficulties in manufacturing it in sufficiently large quantities for practical use were overcome. Brilliant results were soon reported: Herrell Nichols and Heilman of the Mayo Clinic (1944) gave a review of three years of experimental and clinical work; Kirby and Hepp (1944) observed remarkable results in osteomyelitis of the facial bones; Compere, Schnute and Cutell (1945) cured twelve cases of acute haematogenous osteomyelitis with only minor operative procedures. As soon as it was made available to the army, a complete change occurred in the treatment of gunshot fractures. Under the influence of penicillin primary or delayed primary closure became the rule. By 1945 Colonel Mather Cleveland was able to report that 93 per cent of the compound fractures were healed by the time the patients left the hospitals. Buchman, aided by the bacteriological studies of Blair, achieved a high percentage of primary unions in cases of chronic osteomyelitis with discharging sinuses by the use of penicillin before, during and after thorough " saucerization " and immediate suture. The percentage of primary unions after extensive bone-grafting operations was greatly increased even in those in which there had been a preceding infection.

Even to penicillin, however, many pathogens were not susceptible. In streptomycin, discovered by Waksman in 1943, another powerful antibiotic was made available, which controlled many bacteria resistant to penicillin. Aureomycin was added, which in the hands of Buchman is giving even better results than penicillin in the cure of chronic osteomyelitis

with discharging sinuses. Other antibiotics are at present under investigation and they may prove superior to those now employed.

In preparing this section I have been greatly helped by my colleague at the Joint Disease Hospital, Dr Joseph Buchman, who has devoted twenty years of productive clinical research to the solution of the therapeutic problem.

SKELETAL TUBERCULOSIS

CHARLES SUTRO, NEW YORK

In summarizing the modes of therapy for tuberculosis of the skeletal system, one may state definitely that the only new ray of hope has been the discovery of streptomycin. But even this ray is rather dim for the more this antibiotic has been used for skeletal tuberculosis, the more evident it has become that it is not a cure-all. In fact a recent survey of the Veterans' Administration has disclosed that the use of streptomycin *per se* (without local surgical intervention) in the "closed" type of skeletal tuberculosis is of no demonstrable value. Its combined use with local surgery, however, is of considerable efficacy. It aids in temporarily "sterilizing" the osseous or joint lesions. Its most effective use is in mixed infections. According to Bosworth the sinuses heal rapidly in 83 per cent of the ninety-five patients observed.

It is of interest that there are still two schools of thought regarding treatment of skeletal tuberculosis. Bosworth and his group sponsor early surgical intervention irrespective of the age of the patient. Sorrel on the other hand favors long periods of conservative therapy followed by elective surgical intervention. He does not advocate surgical intervention in children before puberty.

In reviewing the literature one is struck with the change in the interpretation of "rest." Several authors, Gill, Kestler and others, have emphasized that prolonged bed rest is not physiologically sound. Severe stunting of growth, due to premature closure of the distal epiphysial plate of the femur and of the upper end of the tibia, is an unfortunate sequel of protracted immobilization for tuberculosis of the bones of the hip. For this reason many authors advocate procedures especially for tuberculosis of the hip which would "by-pass" the tuberculous lesion and permit early weight-bearing. This has been accomplished by osteotomy or by fusion (Hibbs, Chandler, Farkas, Milch, Bosworth, Brittain, Trumble).

Tuberculosis of the vertebral column—Here also there are two schools with divergent opinions as to treatment. Sorrel of Berck-Plage advocates conservative therapy with surgical intervention only in specially selected patients. Mayer and his group also advocate conservative therapy in children for tuberculosis of the vertebral column although strongly in favor of fusion for patients who are beyond the adolescent period. On the other hand Bosworth advocates early surgical arthrodesis of the involved vertebral column for children as well as adults. He does not advocate laminectomy for Pott's paraplegia, but Garceau believes emphatically that laminectomy is indicated in paraplegia when conservative therapy for three or four months fails to give signs of recovery.

ARTHRITIS

A New Approach

OTTO STEINBROCKER, NEW YORK

A number of advances in our knowledge of arthritis and related disorders had gradually accumulated before the epochal announcement of cortisone and ACTH. Amongst the arthritic diseases, the greatest progress had been made in infective arthritis. The sulfonamides and the antibiotics had given us mastery over suppurative, gonorrhoeal and many other forms of

joint infection. Streptomycin had become a potent weapon in some forms of tuberculous arthritis. Light on the evolution of degenerative arthropathy was provided by the work of Bauer and his co-workers. Numerous contributions have been made to the understanding of the clinical picture, mechanism and treatment of lesions of the soft tissues and supportive structures beyond the scope of this limited presentation. The use of procaine and related substances in their diagnosis and treatment has been an inportant forward step. The recognition of the somatizations in musculoskeletal disorders has been a useful development.

Of all the joint diseases, with the possible exception of rheumatic fever, rheumatoid arthritis has been the object of the most extensive clinical and investigative efforts. Although not the most common arthropathy it has been on the whole the most serious and crippling. Important strides have been made in our knowledge of its pathologic basis as a generalized disease which may involve other systems, such as the cardiovascular, central nervous and visceral, as well as the muscles, peripheral nerves and joints. The clinical characteristics of rheumatoid arthritis have been well defined and the need for more exact therapeutic criteria in the evaluation of therapeutic agents has been emphasized. For some time the concept of a general or focal infection in the etiology of rheumatoid disease has been minimized, although the frequency of positive streptococcus agglutinations and, more recently, of positive sheep cell agglutinations in high titre in active rheumatoid disease constitute provocative evidence. Chrysotherapy has been the most widely advocated therapeutic measure although its ultimate contribution to the arrest of the disease has remained controversial, if not extremely doubtful.

Though casual references to the hormones in rheumatoid arthritis and other musculoskeletal diseases had appeared in the literature their significance was not appreciated until Selye made his remarkable experimental and clinical contribution. He noted that the experimental injection of large doses of desoxycorticosterone into rats with intact adrenals produced arthritis and related rheumatic and vascular lesions in some of the animals. In adrenalectomized rats treated in the same way the articular and extra-articular lesions appeared more frequently and in greater degree. Similar lesions were produced in the heart and joints of rats injected with a crude anterior pituitary preparation, but in adrenalectomized rats these effects did not appear. Selye deduced that the lesions were brought about, therefore, via the adrenal glands.

From his observations on the lesions produced in adrenal glands of rats by such varied harmful agents as exposure to cold, drug poisons, infections and emotional disturbances, Selye conceived the theory of "The General Adaptation Syndrome." The experimental disorders thus produced he termed "The Diseases of Adaptation." Rheumatoid arthritis, rheumatic fever and the collagen diseases were regarded by him as "diseases of adaptation" brought about by insufficiency or imbalance of the adrenal secretions with minerolo-corticoids overshadowing glucocorticoid secretion. These original and provocative investigative and theoretical contributions, monumental in scope, remain to be confirmed to a great extent. Their consistency with the collateral, independent clinical application of ACTH and cortisone to rheumatic diseases now to be discussed must depend on further observations, but Selye's work has already added concepts and terms which are part of the current medical language and thought.

The historic advent of cortisone and ACTH with their remarkable reversal of the rheumatoid process has made a tremendous impact on clinical thought and investigation in the rheumatic diseases as well as in almost every field of medicine. The original report of Hench, Kendall, Slocumb and Polley in April 1949 on the effects of cortisone and ACTH in rheumatoid arthritis has been substantially confirmed by other observers.

It is generally agreed that these compounds produce the most uniform and rapid suppressive effect on rheumatoid activity of any treatment yet available. They do not, however, cure the disease, for when the substance is withheld the symptoms return within days or weeks or sometimes months. When administration of the compound is resumed,

control of the symptoms again occurs usually with the same effectiveness. Interrupted administration is preferred on the assumption that the rest periods may favor less potent side-effects and fewer long-range complications from the widespread action of ACTH and cortisone. Even in the early short periods of administration, however, undesirable side reactions may occur by virtue of the varied physiologic functions of these potent hormones.

Although the exact site and manner of their action is not clear at this time it is obvious that they influence or block cellular infiltration and other inflammatory reactions, inhibit fibroblastic proliferation and stimulate filtration through the body membranes and other tissues. They exert powerful antipyretic and analgesic action. Salutary effects on the blood picture, sedimentation rate and some chemical constituents of the blood, such as the albumin and globulin, are consistently produced. These actions of the new hormones appear to account for their anti-rheumatoid effect.

Unfortunately, to provide these benefits the compounds must be administered in doses which are apt to produce in some patients hyperadrenalism or other metabolic abnormalities. These may be transient or persistent. Undesirable side-effects that may arise include rounding of the face and body, hypertension, acne, cutaneous striae, electrolyte disturbances with edema of the extremities or other parts, sodium retention and hypopotassemia, glycosuria with or without hyperglycemia, menstrual disorders, emotional disturbances, cardiac arhythmias and others such as those seen in the Cushing syndrome. Undoubtedly the nature and complete range of complications arising from the widespread use of ACTH and cortisone remain to be explored, so that the contra-indications and hazards must be regarded as incompletely determined at this early stage of their introduction.

In musculoskeletal disorders ACTH and cortisone appear to be equally effective. They have given the most impressive results in our hands in rheumatoid arthritis, acute gout and in reflex dystrophy (the shoulder-hand syndrome). They have also demonstrated definite promise as palliative agents or aids to mobility in rheumatic fever, periarthritis of the shoulder, malum coxae senilis and other forms of severe degenerative arthritis and in the collagen diseases. Our experience in a limited number of cases receiving these substances after manipulation of ankylosed joints or after surgery suggests that they may help to improve functional post-operative results.

It is desirable to begin the administration of these drugs in a hospital where base-line tests can be conducted as a safeguard. The patient is then continued on the smallest dose which will maintain suppression of the symptoms. The size of the maintenance dose varies with the type of disease and its severity. At present ACTH and cortisone are given parenterally but recently the more convenient oral route has been found to be effective. The use of fractions of ACTH by the sublingual method is now under investigation.

The undesirable side-effects of ACTH and cortisone have led to an intensive search for substances providing their benefits without these reactions. A diligent therapeutic study is being made of intermediate or modified steroids produced in the course of the complicated synthesis of cortisone, as well as other substances which might produce similar physiologic responses. Unfortunately, so far these efforts have not been fruitful. Amongst the compounds which have been tried for these purposes are pregnenolone, acetoxy-pregnenolone, desoxy-corticosterone (DOCA) with ascorbic acid, adenosine-5-monophosphate testosterone, progesterone, hydroxy-phenyl cinchominic acid and others.

The experimental observations and theories of Selye, the isolation, synthesis of adrenal compounds by Kendall and others, the isolation, purification and fractionation of ACTH, and the clinical application of these hormones by Hench, Slocomb and Polley to arthritis and other diseases, have altered and enlarged our understanding of specific and general disease processes and added greatly to our therapeutic efficiency. New and limitless pathways of investigation have been opened which directly or indirectly should stimulate further important contributions to progress in arthritis and other diseases.

CEREBRAL PALSY

WINTHROP M. PHELPS, BALTIMORE, MARYLAND

In the field of cerebral palsy there has been marked advance both in diagnosis and treatment especially within the past twenty-five years. The condition was first described by Little in 1862 and the prognosis then was reported as hopeless except in mild cases, and it was thought that practically all were mentally affected. Hence the condition was neglected for many years. However, interest in the disease increased between 1910 and 1920 when infantile paralysis became more widespread. Many of these children were brought to infantile paralysis clinics, since the families knowing that their children had been paralyzed since infancy thought they might fit into this category. It became evident at this time that all of these children were not mentally defective and there were different types of cerebral palsy and all of these children were not "spastic."

Investigations started at that time have shown that cerebral palsy is a group of conditions with brain involvement of one sort or another and that the patients can be classified into specific types depending on the motor characteristics of the part of the brain involved. It was determined that the true spastics resulted from damage to the cortex of the brain or the pyramidal system. A second type of brain involvement resulted in athetosis in which were found changes in the various parts of the basal ganglia. A third type showed ataxia in which the cerebellum was the part of the brain chiefly involved. The rigidities, a fourth type, were seen to differ from the spastics in absence of stretch reflex on examination. This condition is usually the result of diffuse brain damage, from cerebral anoxia for example. A fifth type was congenital tremor.

Until 1920 most of these cases were considered to be the result of birth injury, but subsequent statistical studies of birth injury as such can only account for less than half of the total cases. Other etiological factors which have been found to produce cerebral palsy are mid-line defective development, vertex hemorrhage in prematures as a result of rapid birth and pressure changes from intra-uterine to air pressure. Kernicterus resulting from erythroblastosis associated with Rh factor difficulties is a definite, although not large, etiological factor.

In the birth injury group there have been found two types, those with cortical hemorrhage resulting from pressure of forceps and subsequent subdural hemorrhage, and excessive traction usually in breech deliveries resulting in damage to the basal ganglia. There is also a post-natal group of cases resulting from intercurrent infections with high temperatures, occasionally severe convulsive episodes or the violence of paroxysms of coughing in pertussis contracted under three months of age. The after-effects of encephalitis in infancy and early childhood also can result in cerebral palsy. Further statistical studies show that the instances of mental deficiency, directly due to cerebral palsy, is only about 30 to 35 per cent and therefore the majority of these children are not mentally defective.

Advances in the treatment of these children have been made in five fields.

1. Physiotherapy, occupational therapy and speech therapy. In these fields of therapy special methods of re-education for the establishment of fundamental cortical patterns of motion have been developed, chiefly in the physiotherapy field for the legs, in the occupational therapy field for the development of the normal use of the arms and in the speech field for the development of the usually automatic reflex of the diaphragm, larynx, tongue and lips.

2. There has been marked advance made in the construction of special types of braces and apparatus which can be used specifically to facilitate the development of usually normal automatic patterns.

3. There is definite promise being shown in drug therapy, but only as an adjunct to the previously mentioned methods, in facilitating motion and eliminating unwanted involuntary motions.

4. In the field of surgery the types of orthopaedic operative procedures are gradually becoming clearly defined and those which are effective in cerebral palsy are being developed and classified as to their usefulness. In the field of neurological surgery advances in surgery on the cortex, basal ganglia and lateral columns of the cord have been made.

5. Finally, special educational methods for teaching these children have been developed which would take into consideration the sensory difficulties in sight and hearing as well as the motor aspects of the condition in bringing about more rapid development in the field of learning.

Special training facilities for doctors and therapists who are interested in cerebral palsy are being developed more widely and schools and training centers are being established specifically for these children. Statistical surveys of the number of cases show that the yearly increment is essentially constant as opposed to epidemic diseases and there are about six new cases a year in every 100,000 population of which four are mentally normal and definitely capable of a considerable degree of reclamation.

MUSCLE RELAXANTS IN ORTHOPAEDIC SURGERY

EDWARD B. SCHLESINGER, NEW YORK

The operative management of abnormal neuromuscular mechanisms and their sequelae has always been less than satisfactory. Growing emphasis upon the dynamics of the muscles has imposed new lines of investigation upon traditional orthopaedics. Attempts to influence abnormalities of posture and movement by the use of drugs represent the renaissance of an old and well documented concept—new only in its endowment of Sherringtonian principles and standardized alkaloids.

Burman, actively interested in the treatment of dyskinetic phenomena, in 1938 published the first of a series of reports upon the use of curare and later erythroidine in clinical practice. His findings renewed interest in this therapeutic approach in America, but widespread acceptance awaited the availability of a reliable preparation of curare. The impetus for the development of such a standard alkaloid was largely due to the efforts of Bennett, who thoroughly understood its potential usefulness and subsequently explored it in a series of clinical studies. Since chronicity is a common denomination of most of the states under discussion, aqueous solutions of curare with high initial levels and rapid dissolution of effect betray impractical aspects in clinical use. The inevitable step was the preparation of a long-acting suspension, described in 1946, which tended to obviate the potential toxicity of high early levels inherent in aqueous solutions and also to prolong the desired therapeutic effect.

The use of aqueous and long-acting suspensions of curare, such as tubocurarine, to aid in dissipating the muscular spasm associated with acute skeletal trauma has become the most secure niche for the muscle relaxant group generally. In the treatment of " acute low back " and cervical spine syndromes it may replace less specific traditional medication, and has proven efficacious in the potentiation of traction effect. In general, the search for efficient oral preparations has been unrewarding.

The synthesis of myanesin by Berger and Bradley in Britain in 1946 drew interest to the alpha substituted esters of glycerol, described years before and completely neglected. A 10 per cent solution necessitating rather potent solubilizing agents was proffered to the medical profession in Britain as a substitute for curare, particularly in anesthesia practice. Although its hemolytic properties and transient efficiency militated against its enthusiastic adoption, Stephen and Chandy of Montreal called attention to its interesting effects in ameliorating clinical dyskinetic phenomena. The group involved in the study of muscle relaxants at the Neurological Institute in New York were able to prepare a 2 per cent solution which reproduced the desired effects of the higher concentrations, but was less apt to cause serious hemolysis and phlebitis. This preparation, known as tolserol and lissephen in this

country, has attracted much interest because of its unusual properties. By the intravenous route it is a specific, rapidly acting muscle relaxant whose chief site of action seems to be the bulbo-reticular substance and the synapses of the fairly long pathways mediating control of motor function. Its evanescent effects upon tremor, rigidity, spasticity, muscle spasm and involuntary movement are quite dramatic. The ephemeral nature of its therapeutic action narrows its clinical application to the treatment of reversible states such as muscular spasm and to the amelioration of other mechanisms for short periods of time. As a means of allowing evaluation of contractures or complicated dystonic mechanisms preparatory to definitive treatment, the intravenous preparation serves admirably. Its use as an adjuvant to traction, and as a means of determining the response of the "acute low back" with radicular pain to conservative treatment have been described.

More isolated examples of its occasional usefulness consist in maintaining limb rest after hip-pinning in patients with Parkinson's syndrome, and in dissolving adductor spasticity to allow cystoscopy or abdominal examination. Several oral preparations both in the form of tablet and elixir have been used extensively and described enthusiastically in the American literature. Unfortunately the drug is inefficient by mouth and even in large doses cannot reproduce the best effects obtained by the intravenous route.

Present day pharmacological research, unfortunately or otherwise, depends largely for the vigor of its pursuit upon the attentions of the drug industry. It can be said that the preliminary forays in the field of muscle relaxants have given impetus to their efforts and augurs well for the near future.

In summary, it may be said that in this field of investigation the last decade is chiefly notable for the reintroduction of the idea of attempting to ameliorate neuromuscular mechanisms by physiological rather than purely surgical means, and in giving therapeutic dignity to the concept of muscle relaxants.

We have now completed our topical review of advances in orthopaedic surgery. Your reporter is keenly aware of serious omissions, but limitations of space and time make it impossible to consider such important subjects as the stiff painful shoulder, internal derangements of the knee, slipped femoral epiphyses, the bone dystrophies, neoplasms and the surgery of peripheral nerves. To secure a well-rounded concept of orthopaedic surgery in this country, other phases of development besides the technical must be described.

THE DEVELOPMENT OF NEW SOCIETIES AND OF ORTHOPAEDIC EDUCATION

The significance of the American Orthopaedic Association has already been emphasized in the preceding parts of this paper. It is now time to consider the role of other orthopaedic organizations. Of these, the most important is the American Academy of Orthopaedic Surgeons. An account of its history has been contributed by one of the organizers and a past president of the Academy.

The American Academy of Orthopaedic Surgeons

CARL E. BADGLEY, ANN ARBOR, MICHIGAN

The development of the American Academy of Orthopaedic Surgeons is not an isolated incident in the history of orthopaedics. Rather, it was the natural result among other normal factors of the great stimulus given to surgery in general, and orthopaedic surgery in particular, by the brilliant results achieved and popularized in World War I. An ever expanding growth of orthopaedic surgery, hitherto confined to university clinics and large medical centers and cities, spread by popular demand into the larger hospitals and clinics throughout the country. Capable, well-trained men were attracted in ever increasing numbers into the speciality of orthopaedic surgery.

The American Orthopaedic Association, composed by constitution and inheritance of a restricted membership, had for years by custom as a courtesy held annual meetings at the home of the current president. A constantly increasing attendance each year of well-qualified younger orthopaedic surgeons or guests demonstrated to the members of the American Orthopaedic Association the obvious need for the formation of a new organization constituted on a much larger scale. The concept was expressed by some to maintain the American Orthopaedic Association in a capacity somewhat analogous to the Senate and to develop a much larger membership in the new organization akin to the House of Representatives. There was, however, no official act by the American Orthopaedic Association itself.

The Academy historian, Philip Lewin, states: "On October 11, 1931, Willis Campbell unofficially initiated a meeting of a few members of the American Orthopaedic Association at the Congress Hotel in Chicago for the purpose of discussing a matter of vital importance to the development of American Orthopaedic Surgery." Campbell, among others, was fully cognizant of the need for an annual gathering of all interested in orthopaedic surgery. He had been much impressed with the increasing size and evolution of the Clinical Orthopaedic Society which, outgrowing its original purpose of a travel club visiting clinics annually throughout the Mid-West, had developed into an organization of such size and scientific caliber that scientific programs were required to replace the clinical demonstrations.

At this historical 1931 meeting and at several meetings the following year, Campbell launched a program for the development of a national organization for orthopaedic surgeons in the form of an academy whose primary object, as expressed in its constitution, "shall be for the advancement of orthopaedic surgery in all of its phases." Particularly, recognizing the broad scope and appeal of orthopaedic surgery and its dependence upon the allied sciences, one of the purposes of the meeting was to allow attendance as guests of any member of the medical or allied professions.

On January 13, 1933, at a regular annual meeting of the Clinical Orthopaedic Society in Chicago, through the instigation of Campbell and his selected committee, a formal organization meeting of The American Academy of Orthopaedic Surgeons was held. The members of the Clinical Orthopaedic Society properly qualified by training thus became the nucleus for the newly formed American Academy of Orthopaedic Surgeons. Officers of the new organization were duly nominated and elected with E. W. Ryerson as president of the organization meeting, and Willis Campbell President Elect. During the ensuing year a constitution was established. Membership in the organization was restricted to individuals who had received adequate training in orthopaedic surgery and had practised orthopaedic surgery exclusively at least three years subsequent to his period of training. In 1937, for the first time, does it appear in the articles of the by-laws that the applicant must be certified by the American Board of Orthopaedic Surgeons.

The 1934 meeting of the Academy of Orthopaedic Surgeons proved the need of such an organization. To a large enthusiastic attendance was presented a most stimulating program. The first invited foreign guest of the Academy was the late Naughton Dunn who in 1934 distinguished himself by his wit and humor as well as by his scientific contribution.

The growth of the Academy continued apace, attracting not only orthopaedic surgeons but many other interested guests. At first there was a retention of the old custom of the Clinical Orthopaedic Society, from which the Academy emerged, to hold a day for clinical presentation. The meetings were held in large cities with suitable clinical and hotel facilities. The increasing attendance at the annual meeting soon restricted the location to a few large cities, chiefly Chicago, where ample facilities for hotel accommodations could be obtained. Commercial firms, quick to recognise the value of exhibits, helped to meet the financial costs of the Academy by renting space. Scientific exhibits became of increasing importance and supplemented the scientific papers. An audio-visual program was initiated at the 1939 meeting in Memphis which has developed into such an important part of the annual meeting that

1,700 members and guests sitting in two halls of the Waldorf-Astoria in 1950 viewed this part of the program.

In 1942, through the interest of J. E. M. Thomson and a favorable executive committee, the Instructional Courses of the Academy were begun. The success of this feature of the meetings has led to its continuation. The organization and the functioning of this complicated portion of the program, although open to minor criticism, have in general been most satisfactory. Little time has been lost from the regular scientific program as Saturday, Sunday and Monday mornings have been utilized for this portion of the program. The seventh volume of the Instructional Course lectures has just come from the press, a valuable addition to any orthopaedic library.

In 1943 there was a combined meeting of the American Academy of Orthopaedic Surgeons and the Clinical Orthopaedic Society, celebrating a decade of existence for the Academy.

As the Academy has grown in importance and become truly " big business," it became obvious that there was a need for a central office for the affairs of the Academy. Such an office has been established in Chicago and now serves not only the Academy but the American Orthopaedic Association, The American Board of Orthopaedic Surgeons and the Clinical Orthopaedic Society. It has a complete addressograph file for these organizations. Its services are available to others on a " cost plus " basis.

The American Academy of Orthopaedic Surgeons has now grown to the size where it is inevitable that normal expectancy of future growth will make it physically impossible to continue its meetings with the physical facilities of hotels. Restriction of attendance has been suggested but the obvious evidence of its success on the broad principle expressed in the constitution of the Academy, " The object of the Academy shall be the advancement of orthopaedic surgery in all of its phases," shows the need and dependence of the orthopaedic surgeon on his medical confrères and the allied sciences. Future meetings may by necessity have to be held in locations with suitable auditorium accommodation.

The American Society for Surgery of the Hand

JOSEPH BOYES, LOS ANGELES, CALIFORNIA

In the fall of 1945, when World War II was drawing to a close, there had been set up in the United States Army Hospitals a system of treatment of casualties of the hand wholly different from anything seen in previous wars—nine army hospitals had been established as centers where injuries of the hand were treated as an entity. This deliberate plan of concentrating the treatment of injuries of a specific anatomical region rather than classifying them on the basis of a surgical speciality had been established by the Surgeon-General of the United States Army, Major-General Norman Kirk.

Early in the war years, because of his long familiarity with problems of hand injuries and especially reconstructive surgery of the hand, Sterling Bunnell had been asked to visit the various army hospitals and make recommendations for treatment of the increasing number of hand injuries. As a result this type of injury was assigned to nine army centers and these hospitals were staffed with men whose enthusiasm, set free from the traditional views of tissue surgery and stimulated by frequent visits from Dr Bunnell and later other consultants, led them into the fascinating field of reconstructive surgery of the hand. The results were outstanding and the new procedures developed and the new ideas generated by this group showed that here was a new field of surgical endeavor well able to keep a man's full faculties exercised. Here was a field where plastic surgery, neurosurgery and orthopaedic surgery would be combined and a knowledge of anatomy in its finest details essential; where a delicate touch and extremely fine skill were required; and where all the imagination a man possessed could be utilized to help him restore to the wounded the function of this most essential part.

When it became apparent, with the end of the war and subsequent demilitarization of

the country, that these centers would be closed and the staff returned to civilian life, some means was sought to keep alive the spirit of the group and further the common interest in problems of surgery of the hand. A correspondence club was considered but it was decided to make a more closely knit organization; and thus the American Society for Surgery of the Hand was organized. In 1945 a small nucleus met to discuss the problem and to invite into the proposed small organization those surgeons throughout the country who were known to have been interested in and to have contributed to the development of this field of surgery. The organization began on a small scale and has grown slowly. The present membership is sixty-two. Annual meetings have been held and the topics discussed have apparently been of great interest to the profession as a whole, for the meetings have been attended by as many as nine hundred.

The establishment of an organization such as this has settled the question of where surgery of the hand belongs in the realm of surgical specialities. The aim of the hand surgeon is not to treat a tendon injury, a fracture, a nerve injury, or to replace skin on a burned part, but to restore function to the extremity as a whole; not only to enable the hand with sensation to grasp objects, but to enable the individual to place that essential organ in its most useful position by means of a functioning arm and shoulder. Truthfully the hand, as Bunnell says, " starts at the opposite cerebral cortex " and does not start at the wrist, which is palmistry. The modern concept of reconstructive surgery of the hand and the rational approach to the problems of treatment which the Society is attempting to promulgate are but the extended ideas first felt by the group under the stimulus of Bunnell's teaching and as exemplified in his textbook, the vade-mecum of every hand surgeon.

The Place of Orthopaedic Surgery in the Teaching Program of the University Medical Schools

LeRoy Abbott, San Francisco, California

In 1947 I was able to secure data concerning the status of orthopaedic surgery in fifty-three of our medical schools. In seventeen of these schools orthopaedic surgery had acquired major status with a certain measure of control over the amount and distribution of budgets, appointments and promotions on their staffs, and representation on the executive advisory committees of the deans of their respective schools. Thirty-six were subdepartments of surgery; that is, in approximately one-third of our medical schools the orthopaedic divisions have autonomy.

In 70 per cent of the schools fractures, osteomyelitis, joint infections and bone tumors were treated exclusively on the orthopaedic service. In the remaining schools the treatment of these conditions was divided between orthopaedic surgery and general surgery, while in a small percentage they were treated on the general surgical service. In 20 per cent, amputations were cared for exclusively on the orthopaedic service; in 8 per cent, on the surgical service; and in 72 per cent the treatment was divided between the two services. Acute surgery of tendons and the treatment of infection of the hand were assigned in varying proportions in the different medical schools to both orthopaedic and general surgical services. The teaching of the subjects of fractures, osteomyelitis, joint infections, bone tumours, amputations, surgery of the tendons and of the hand was divided between the two divisions of surgery in about the same proportion as the treatment of these conditions.

In reply to the question: " Do you have facilities for complete training in orthopaedic surgery including fractures, children's orthopaedic surgery and fundamental sciences? " forty-one indicated that they had all the necessary facilities and ten were lacking in some particulars.

During the past year, the Division of Orthopaedic Surgery of the University of California Medical School has enjoyed the status of a major division of surgery. With this independence

and authority to control our future development, integration of our teaching with other divisions of surgery for the benefit of the undergraduate and postgraduate student is to be desired. We will then fulfil the obligation which will justify the newly acquired autonomy. As Carl Badgley, my former associate at the University of Michigan, so well expressed it: "Our aim should be first, to train doctors; second, to train surgeons; and then to train orthopaedic surgeons."

Postgraduate Education in Orthopaedic Surgery after World War II

A. R. Shands, Jr., Wilmington, Delaware

During the latter years of World War II it became evident to the American Academy of Orthopaedic Surgeons and the American Orthopaedic Association that due to the increased interest of the military physicians in orthopaedic surgery there would be a very large demand for orthopaedic training when peace-time conditions once more existed. With this thought in mind these two organizations appointed a six-man Joint Committee on Postgraduate Training with Dr Ralph K. Ghormley of the Mayo Clinic as chairman. The objective of this Committee was to increase facilities for orthopaedic training in order to provide for the medical veteran desiring to become a qualified orthopaedic surgeon. The author of this article upon discharge from the service became the seventh member of this Committee and was made its secretary.

The first work of the Committee was to review the approved training services in the United States and the services in the larger hospitals which had no formal training. After this review, those services with formal approved training which were considered eligible were asked to increase the number of their residents, and those hospitals without approved training which had the necessary facilities and staff were asked to start a formal training service and apply for approval. The Council on Medical Education and Hospitals of the American Medical Association agreed to give temporary approval to all new orthopaedic services established to meet this emergency which were approved by the American Board of Orthopaedic Surgery and the Committee on Postgraduate Training. In the first two years the number of training services was increased from approximately seventy-nine to 238 and the number of residencies from 253 to 726. These have now increased to 257 services and 779 residencies. Realizing that the sudden expansion of orthopaedic training services might not be best for orthopaedic surgery as a whole and might result in some poorly trained specialists, the Postgraduate Training Committee with the sponsorship and approval of the Council on Medical Education and Hospitals of the American Medical Association reviewed the training afforded by these services in 1949. This was done by twenty-eight carefully selected orthopaedic surgeons. The reports of these surgeons resulted in the changing of the type of approval of approximately 20 per cent of these services.

With this expansion of the training services approved training was given for the first time in the Veterans' Administration Hospitals and in the larger hospitals of the Army and Navy. Some of these government services are now among the best in the country. Most of the new services were awarded training only for adult and fracture work but many were allowed credit for children's orthopaedics and basic science as well.

The American Board of Orthopaedic Surgery

Allen F. Voshell, Baltimore, Maryland
(*President of the Board*)

The tendency of an increasing number of physicians to limit their practice to a special branch of medicine has made it essential that the various recognized specialities organize qualifying boards to certify applicants who prove themselves competent. Recognizing this need, three major orthopaedic groups—the American Orthopaedic Association, the Section

The Alfred I. Du Pont Institute, Wilmington, Delaware. Opened in July 1940 by the Nemours Foundation, it represents one of the most carefully planned and well organized private philanthropies for crippled children. Dr A. R. Shands, the Medical Director, spent two years of study and visited over 100 institutions in Europe and the United States before submitting building plans for the Institute. The bed capacity is eighty-five. There are schoolrooms, an auditorium, indoor and outdoor pools, a physical therapy department and playrooms. There is a fourteen-bed research ward, and laboratories for research in biochemistry, bacteriology and pathology. There are a library with 6,000 volumes and a museum for bone specimens. The Institute has had the following four-point program: 1) Hospitalization of the crippled child; 2) education of the crippled child; 3) research on problems related to the crippled child; and 4) postgraduate training of the workers in the field of crippled children.

Veterans' Administration Research Hospital now under construction on Chicago's lake front, adjacent to North-Western University Medical School campus. This beautiful building is typical of the progressive spirit and the accomplishment of the Veterans' Administration under the able direction first of General Hawley, and now under his successor, Dr Paul Magnuson.

on Orthopaedic Surgery of the American Medical Association and the American Academy of Orthopaedic Surgeons—united in organizing a certifying Board. This Board was incorporated in the year 1934 as the American Board of Orthopaedic Surgery, Inc., and is officially approved by the Advisory Board of Medical Specialities and by the Council on Medical Education and Hospitals of the American Medical Association.

It is the purpose of the Board to raise the qualifications and standards for the practice of orthopaedic surgery and to certify those surgeons who voluntarily comply with its requirements. The following facts are pertinent results of the Board's activities and principles:

1. Certification by the Board forms a criterion by which interested lay and professional groups may judge the qualifications of an orthopaedic surgeon and will be a reliable guide in the choice of consultants.
2. Board certification has been made a requirement for staff appointments in hospitals and a pre-requisite for recognition as a specialist in orthopaedic surgery by other organizations, though this is not a purpose of the Board nor was it initiated by it.
3. Certification by the American Board of Orthopaedic Surgery is one of the essential requirements for membership in the American Orthopaedic Association and the American Academy of Orthopaedic Surgeons.
4. Qualification of applicants for certification by the Board indirectly results in improved teaching of orthopaedics in medical schools and better care of patients on orthopaedic services of hospitals that have approved resident training programs.

During the past sixteen years improvements in the training of orthopaedic surgeons have been many, with perhaps the stress placed upon the basic sciences as an important phase of modern orthopaedics, and the need for some fundamental general surgical experience preliminary to specialized orthopaedic training. The equivalent of six months in the basic sciences with emphasis upon anatomy and pathology has been a requirement of the Board for five years, but a year of general surgical experience has just been instituted and from now on will be required. A system of examining candidates to evaluate their capabilities has been evolved and it seems to merit the statement that it is fair and essentially accurate, particularly since two examinations are made of eligible candidates, one early in his training and the other after two years of specialized practice. About one thousand orthopaedic surgeons have been certified to date in the United States and Canada and there are about three hundred more in training or in process for certification.

Orthopaedic Research

VERNE T. INMAN, SAN FRANCISCO, CALIFORNIA

[The clinical progress of orthopaedic surgery is largely dependent on research. This is being conducted in so many fields and by so many different men that it is impossible even to list them. It is, however, important to cite a single instance of what is being done and the work that is being conducted at the University of California is given as an example of the type of study which is adding greatly to the sum total of our knowledge—L. M.]

It is our feeling that the research activities of the Division of Orthopaedic Surgery are of equal importance to the practice of clinical surgery and instruction. It is the research that distinguishes the university from a mere trade school. The fields of research should extend beyond clinical investigation and include studies of a fundamental nature. In fact, the clinical activity should be the end-result of new ideas originating from such fundamental investigations.

With these concepts the Division of Orthopaedic Surgery has sponsored a Biomechanics Group. This group is co-operating in investigations in the fields pertaining to the locomotor system.

An investigation of the mechanics of motion involves problems which can only be attacked

and quantitatively analyzed by individuals who are familiar with engineering technique and methods. Since these problems lie within the field of the engineers we have sought their close co-operation and assistance. Within the Biomechanics Group, the work has been divided into two general fields. One involves the study of the mechanics of the human body and the other is restricted to medical and biological problems. Those dealing with the kinematics and kinetics are placed under the supervision of engineers, the medical group acting as consultants and advisers. Those problems which are fundamentally medical in nature are supervised by medical personnel and assistance is sought from the engineers when indicated.

The extent of our interest in the fundamental problems is indicated by a list of the projects which at the present time are being actively pursued:

A. *Fundamental studies of locomotion under the direction of engineers.*
   1. Displacement patterns of the various segments of the body in all planes of space during locomotion.
   2. Angular acceleration of the various segments of the lower extremity.
   3. Recording of floor reactions using force plates.
   4. Calculations of moments about the joints of the inferior extremity.
   5. Electromyographic studies to determine the activity of the various muscle groups and individual muscles during locomotion.

B. *Studies under the supervision of the medical personnel.*
   1. Fundamental studies on the dynamics of muscular contraction.
   2. Studies on electromyography in an attempt to correlate the electrical activity with mechanical activity of muscle.
   3. Studies on the chemistry of muscle and the contractile unit.
   4. Studies on atrophy and hypertrophy of muscle.

C. *Fundamental studies on pain.*
   1. The innervation of the deeper tissues by staining with methylene blue to determine the type of nerves and their distribution.
   2. Study of thresholds to pain in normal subjects.
   3. Study of the extent of the radiation of pain from experimental irritative skeletal lesions.
   4. Clinical study of pain in amputees.
   5. Study of the vascular supplies to stumps of amputees.
   6. Electrophysiological studies on the small fibres of mammalian nerves.

We have at the present time approximately twenty-seven full-time research personnel sponsored by private funds and grants from the National Foundation for Infantile Paralysis and Advisory Committee on Artificial Limbs. No departmental funds from the University of California are being utilized.

PUBLIC HEALTH PROGRAMS FOR THE ORTHOPAEDICALLY HANDICAPPED

SAMUEL WISHIK, NEW YORK

Director, Bureau of Child Health, New York Department of Health

The twentieth century was well advanced before there was appreciable assumption by government of responsibility for crippled children other than in institutional care. On the national level some programs for maternity and infancy hygiene which were established by the Shepard-Towner Act of 1921 gave a small amount of service to crippled children. The specific federal legislation that launched a nation-wide program for meeting the problem on more than a token basis was the Social Security Act of 1935. This Act, under Title V, Part 2, authorized an annual appropriation of $2,850,000 for grants to the states to extend and

improve services to crippled children, especially in rural areas and areas suffering from economic distress. Each state was granted $20,000 plus an additional amount determined by the number of crippled children in need of service, the cost of care and the financial need of the state. The amount granted had to be matched dollar for dollar with state or local funds. In 1939 the total annual amount for the program was increased to $3,870,000 with $1,000,000 of it not requiring state matching. In 1946 the annual appropriation authorized was raised to $7,500,000 with half requiring matching and in 1950 this was doubled to $15,000,000.

The first funds under the Social Security Act were passed to some of the states in February 1936. By 1939 every state had received approval of a plan and grants of funds. A variety of administrative patterns developed. The official state agencies administering the plans were health departments, welfare departments, education departments or separate special commissions. The trend over the years has been to shift more and more to health departments. The administrative variety resulted from the different activities that existed at the time the Act was passed, particularly the tradition of Welfare Departments giving institutional care to the mentally and physically handicapped.

At both the federal and state levels committees of orthopaedic surgeons and other professional and lay persons help advise on the policies of the programs. The Children's Bureau maintains a staff of consultants in the fields of orthopaedics, physical therapy, pediatrics, public health nursing, social work, nutrition, hospital planning and administrative methods to give assistance to the state agencies which in turn offer similar consultation to the local personnel working in the program.

One of the outstanding developments under the state programs has been the itinerant clinics conducted by a professional team composed of an orthopaedic surgeon and some or all of the following: public health nurse, medical social worker, pediatrician, physical therapy technician and vocational rehabilitation worker. The clinics are held in areas which do not otherwise have access to specialized services. Consultation on diagnosis and recommended treatment is given to the local physicians and assistance is given to other local professional persons in meeting the total needs of the crippled child. When hospital care is necessary the program pays for it if the work is done by qualified specialists in hospitals which meet acceptable standards in facilities, personnel and practices. Diagnostic services are available to all but a means test is usually applied to determine eligibility for treatment services. Approximately 25 per cent of the children seen in the clinics are referred for hospital care. Convalescent care in institutions or in foster-homes is furnished when needed. In 1947, 485,000 handicapped children under twenty-one years of age were listed on the state registers.

Just about the turn of the century first steps were taken to bring special education to crippled children. Minnesota started education in the state institution for crippled children. In New York City the public school system sent teachers into children's orthopaedic hospitals and into the homes of home-bound children. This practice spread slowly until at present there is hardly an institution for crippled children that does not give education along with medical care.

In the first twenty years of the century public departments of education in large cities built and maintained special residential schools for handicapped children. More recently the trend has been towards day-time education rather than full-time residence. Special day schools exist in Newark, Chicago, Baltimore and a number of other cities. Special schools may provide wide corridors, easily accessible and wide exits, elevators, ramps, special auditorium and gymnasium facilities, treatment rooms, treatment swimming pool, rest rooms, lunch rooms, industrial training rooms and special equipment such as wheel chairs or adjustable benches and desks. Children are transported from all parts of the city to the centralized school. Transportation under such a program becomes an extremely expensive and difficult problem.

The more recent trend in most parts of the country is away from the separate special school and to the special classes in certain of the regular schools. This pattern offers the

advantages of giving schooling closer to the child's home and also greater opportunity for the handicapped children to mingle with the normal groups. The first special classes were established in Chicago and New York City just about 1900. By 1914 Cleveland, Detroit, Baltimore and Philadelphia also had such classes. The history of day-school classes for crippled children in the United States shows a gradual transition from private to public responsibility. In various cities, private schools and such organizations as the Association for the Aid to Crippled Children sponsored such special classes during the early 1900's. Special classes are usually located on the ground floor level. They have fewer pupils per teacher and may have attendants to assist with the children. Physical therapy and occupational therapy under medical direction are given in some of the classes. It is estimated that education in a special class is four to six times as costly as for the regular program. Although transportation is less expensive than that in the special school it is still a large item. When the number of children is small, departments of education usually contract for their transportation. For larger groups, special buses have been constructed and are operated by the school system.

It is the generally held belief in the United States that handicapped children should receive their education in as regular an environment as possible and that they should not be separated from other children unless definite advantage accrues from such separation. Therefore, when a child no longer needs special instruction, treatment or handling he is transferred to a regular class despite the persistence of a handicap. The most recent trend is towards the so-called divided program in which a child spends most of his day in a regular class and goes to the special class in the same school only during those hours when he needs and receives special care. In any event, the decision concerning placement must depend to a large degree on the medical diagnosis and recommendation.

State support of local school systems in giving special education to handicapped children did not begin until 1915. In that year Ohio and shortly thereafter New York and other states first granted supplements over and beyond the usual grant for education. In 1914, 3000 children attended special classes in the United States. By 1948 the number of children in special classes had grown to 30,000 and 1,469 school systems were giving some type of special education to about 440,000 children with various kinds of handicap. It is recognized that such children should start their education earlier in life and should be able to continue it longer than the normal child. Twenty-four states now permit modification of the usual minimum or maximum educational age levels.

At the federal level the United States Office of Education in the Federal Security Agency gives consultations to state departments of education and helps to set standards for the education of crippled children. As yet, however, no federal grants of funds have been made available to the states for educational purposes.

This report on the public health aspects of orthopaedic care in the United States has thus far been largely limited to children. But much can be said about public health services to adults. In 1917 Congress passed the Smith-Hughes Act establishing a federal agency to administer grants for vocational education. In 1918, under the impetus of World War I, the Soldiers' Rehabilitation Act was passed to offer retraining to disabled veterans after their discharge from the armed forces. Placing the rehabilitation of returning soldiers under a civilian agency established the framework for a program of vocational rehabilitation of civilians. Emphasis was still given to industrial injuries but by 1920 the National Vocational Rehabilitation Act was passed along broader lines. Allotments were made to states on the basis of population. The Social Security Act of 1935 established a permanent rehabilitation agency not requiring periodic renewals, increased the grants and increased the amount to be used by the federal administering agency. In 1939 the Social Security Act was amended to authorize appropriations of $3,500,000 a year for grants to the states, set a minimum allotment for any state at $20,000 and authorized $150,000 a year for federal administration. In 1939 under government reorganization the Board of Vocational Education

was placed in the United States Office of education in the Federal Security Agency. In 1925 the National Civilian Rehabilitation Conference was organized and its name was changed in 1927 to the National Rehabilitation Association. It is a professional organization of rehabilitation workers whose objective is the promotion of measures that will improve the condition of the disabled. It publishes a bi-monthly periodical, *The National Rehabilitation News*.

Twelve states had rehabilitation legislation on their statute books when the 1920 federal law was passed. During the next year nineteen additional states adopted rehabilitation laws. Within two years after the passage of the Act, two-thirds of the states had accepted federal aid and had established state boards for vocational education. It was not until 1940, however, that the last state participated in the program. Under the federal program a disabled person is defined as any person who by reason of a defect whether congenital or acquired by accident, injury or disease is or may be expected to be totally or partially incapacitated for remunerative occupation. No means test or statement of financial eligibility and no age limit exist at the federal level. Training may be secured in schools and colleges, public or private, from tutors or correspondence courses or by supervised experience in business establishments.

In 1922 interpretation of the Act was revised to permit expenditure for orthopaedic appliances when the appliance was essential to the vocational rehabilitation of the individual but not merely for physical reconstruction or restoration of the individual alone. In 1926 this was further liberalized. In 1943, this time because of the manpower shortage during World War II, vocational rehabilitation was expanded considerably. Physical restoration was permitted in order to render a disabled or handicapped person more employable. Approximately $20,000,000 a year were made available for grants to the states as needed. By agreement with the United States Children's Bureau, the Crippled Children's Services in the states offer medical correction to most of the patients under twenty one years of age, the State Vocational Rehabilitation Agencies to those over twenty-one. Vocational counselling is usually available by sixteen years of age, though earlier services are offered in some areas. The 1943 Act accelerated the program tremendously. From 1920 to 1943, 210,000 persons had received some type of vocational rehabilitation service. In the next five years the number was 219,000. The average cost of vocational rehabilitation has been $300 to $500 per case which is less than the cost of maintaining a dependent person for a single year.

The disabled unemployable citizen becomes a drain upon society. Failure to prevent disability and failure to offer full potential rehabilitation are extravagances which no community can afford. The orthopaedic surgeon holds the key position as a party to the co-operative efforts of individual clinicians and teachers and the combined resources of voluntary groups, institutions and government.

LAY SOCIETIES

Most orthopaedic surgeons are much more keenly aware of the lay societies active in the cause of the crippled than they are of governmental agencies. Particularly prominent among these lay groups, and of great constructive help in the fight against poliomyelitis is the National Foundation for Infantile Paralysis. As an example worthy of being followed, a section is being devoted to this society.

The National Foundation for Infantile Paralysis

Miss Dorothy Ducas

Public Relations Director of the Foundation

This is a non-profit membership corporation supported by the American people through the March of Dimes each January. It was founded in 1938 to " lead, direct and unify " the fight against poliomyelitis. At present the national Foundation has 2,822 Chapters manned by volunteers in the United States, Alaska, Hawaii and Puerto Rico. Each Chapter is prepared to spring into instant action to assist infantile paralysis patients in the locality.

The organization has three basic aims:

1. To maintain nation-wide systematic aid in regular and epidemic outbreaks of poliomyelitis.
2. To encourage through scholarships, fellowships, and assistance to schools and professional organizations the recruiting of additional scientists, physicians, nurses, physical therapists and other professional workers in the poliomyelitis field.
3. To support intensive scientific research with the object of discovering a preventive, a specific cure and improved treatment of the disease.

The National Foundation's continuous search for a medical preventive, and for methods of ameliorating the crippling after-effects of poliomyelitis, together with its vast epidemic aid program, constitute the most comprehensive attack on a single disease ever made by a private agency.

Half of the money raised by the March of Dimes goes to the national headquarters of the organization for its program of scientific research, education and emergency aid in epidemics. The other half is retained by the county Chapters for care and treatment of local poliomyelitis patients who need financial help and, in emergencies, is used also to supplement national epidemic aid. The Chapters work with hospitals and recognized health and welfare agencies, rendering financial aid where needed, regardless of the age, race or creed of patients.

In less than thirteen years since it was founded by the late President Roosevelt the National Foundation has made grants and appropriations totalling some $28,500,000 for research, education and non-epidemic medical care. In the same period about $94,200,000 has been spent for epidemic aid and patient care.

Research sponsored by the March of Dimes has uncovered the fact that infection with poliomyelitis is not a rare occurrence. Approximately 80 per cent of the people in the United States have been infected by one or more of the polio viruses by the age of fifteen. However, only a small percentage of these developed clinical symptoms; the majority are seldom aware that they have been infected. It has been learned that specific antibodies exist in the blood of adults conferring a measure of immunity to the paralytic disease, but immunity to one of the viruses does not provide immunity to the others. National Foundation research grantees are now determining exactly how many different types of virus can cause human poliomyelitis, with a view to attempting a combined preventive vaccine or serum against all types. At the same time the search for a drug to prevent paralytic poliomyelitis continues. It is known to-day that nerve cells, once invaded by the virus, are not always destroyed. Many may recover. Thus it is reasonable to believe that paralysis and death can be decreased if an agent can be produced that can destroy the virus within the nerve cell.

Among the foremost accomplishments in the research field are those which have led to a substantial reduction in the death-rate from bulbar poliomyelitis, in the development and improvement in the techniques of orthopaedic surgery and more widespread use of physical therapy. More than 2,000 physical therapists have been trained in recent years in approved schools under National Foundation scholarships.

Research in muscle and joint action has brought about the development of electronic instruments for testing and strengthening weakened muscles and has enabled engineers to create new and greatly improved prosthetic devices of all types. Recent studies also have shown that strenuous physical activity during the pre-paralytic stages of infection can increase the amount and extent of involvement, as can chilling. Thus widespread dissemination to the public of the precaution to avoid over-fatigue and chilling has been undertaken for the last three years.

Because of greater knowledge of the nature of infantile paralysis and because of improved techniques and prompt medical attention, extensive deformity and distortion, once relatively common, have been substantially reduced, while possibilities in the field of mental and physical rehabilitation are being explored and expanded.

ORTHOPAEDIC SURGERY IN THE SECOND WORLD WAR

Major-General NORMAN T. KIRK *
Surgeon-General, United States Army

The excellent medical service rendered to the American Army in World War II can to no little extent be attributed to the consultant service of the Medical Corps. Consultants in surgery and its specialities, including orthopaedic surgery, and in medicine were established in the office of the Surgeon-General; in the nine service commands in the Zone of Interior; in each overseas theatre and in each Army.

The members of the American Orthopaedic Association and of the Academy not in the military service, acting individually or as members of the Orthopaedic Panel of the National Research Council, were of great assistance in the evaluation of the professional qualifications of the Reserve component concerning the training of the individual officer in orthopaedic or traumatic surgery and in other ways. This information or Board certification was of great value in determining the officer's MOS number and his initial duty assignment. The orthopaedic consultant not only advised regarding specialized care of the sick and wounded in the command to which he was attached but controlled the assignment, relief or reassignment of those medical officers carrying the orthopaedic MOS number, and in addition recommended his up or down grading according to the officer's ability.

The orthopaedic work load was a stupendous one. There were never enough medical officers trained in this speciality available to meet the needs. Twenty per cent of all wounded sustained compound fractures and there were 598,000 wounded in the American Army. Yet 375,000 of these wounded were returned to duty overseas and more than 70,000 in the Zone of Interior. In addition there were thousands of musculoskeletal injuries incurred in accidents during training, transport and in combat requiring specialized care. Statistics are not available to me regarding the number of arthrotomies performed for intra-articular derangements, backs examined for pain or feet treated for sprain.

The fixation-traction splint for immobilization of the lower extremity developed by Thomas and introduced into World War I by Sir Robert Jones continued to be the life-saving splint in the second world war. We in America for various reasons prefer the Keller modification—the Army hinged half-ring splint—for transportation of fractures of the lower extremity from combat or the site of trauma to hospital and for suspension when skeletal traction is used in definitive care. As recorded in history, the Thomas splint alone reduced the mortality rate from 50 per cent to 15 per cent during transportation of gunshot fractures of the femur from the aid station to the casualty clearing station in the British Army in World War I.

As in World War I all wounds were thoroughly debrided, left open and drained with a light vaseline gauze pack. Plasma, whole blood and the antibiotics were of great assistance to the surgeon in the prevention of shock, the resuscitation of the patient and the prevention and control of infection in the wounded. After débridement, compound fractures were immobilized in well-padded plaster encasements for transfer to the orthopaedic service of a general hospital in the theatre. Air lift played an important role in this transportation in many theatres. On the third to fifth day after initial surgery and after the patient's arrival in the general hospital the plaster casing was removed from the fractured extremity. If the wound looked clean, cultures were not taken but closure by layers was accomplished where possible or a split-thickness skin graft was performed. Dependent drainage was established if the wound was through deep muscle tissues. If the wound looked " dirty "—if it contained

* As a member of the American Orthopaedic Association, Major-General Kirk had made notable contributions to bone-graft surgery and to the treatment of fractures before being called to take medical charge of the army. It is the first time in our history that an orthopaedic surgeon has been called to fill such a high military post; it is a source of pride to our speciality that he was called and that he acquitted himself so admirably—L. M.

dead tissue because of insufficient initial débridement—it was further débrided and placed back in plaster.

Skeletal traction with suspension from a Balkan frame was the method of choice in fractures of long bones. The compound fracture was thus converted into a simple one and with the aid of penicillin parenterally 86 to 90 per cent of the wounds healed by primary union. When the fracture became firm with proper length and alignment a plaster encasement was applied and the patient was ready for transfer to the Zone of Interior for definitive care and rehabilitation. The cast was removed on arrival and suspension traction continued until consolidation occurred while joints were being mobilized and muscles redeveloped. Internal fixation of fractures, particularly in the shaft of the femur, with metal plates and screws was done in certain cases at the time of " reparative " surgery, when the wound was healed. The end-results as seen in the General Hospital orthopaedic wards in the Zone of Interior were not as good as those following skeletal traction.

The hanging cast which gives excellent results in simple fractures of the humerus was not satisfactory in the open gunshot wound until after the wound had healed. Tendons and nerves healed better if their suture was delayed for some two to three weeks after healing of the wound. The guillotine or open circular amputation, popularized in the first world war, proved to be the operation of choice when amputation was necessitated because of trauma or for the control of infection. The open end of the stump, early in the war, was dusted with sulphonamides; later only vaseline gauze was used. Skin traction to the stump by sterile stockinet glued with " ace adherent " assisted in healing and gave ideal results if continued without interruption.

Centers were set up here at home in the sixty-five General Hospitals to give specialized care to the sick and wounded as they arrived from overseas theatres. Every General Hospital became an orthopaedic center with an orthopaedic section as part of the surgical service except in a few hospitals which treated medical or psychiatric patients only. Each of some 400 overseas hospitals and hospitals here at home had its orthopaedic section. There were in operation five amputation centers, fifteen neurosurgical, nine plastic, two vascular, five thoracic, two blind, three deafness, two arthritic centers and others. The orthopaedic surgeon played his part well in the team along with the neuro-surgeon, the urologist, the ward officer, the plastic surgeon, the nurse, the dietician and the ward man in the surgical care and rehabilitation of the 1,400 paraplegic patients.

Upon my personal request, Dr Sterling Bunnell of San Francisco became a civilian consultant and for two years taught the surgery of the crippled hand. A center in each service command was established at his request for this purpose. Medical officers known to him and others as skilled or interested in this type of surgery were transferred to these centers as were the more difficult hand cases. He estimated that 20,000 severe hand injuries occurred during the war years. A new or almost new orthopaedic speciality was born.

Infected wounds with chronic osteomyelitis were the exception rather than the rule in comparing patients of the two wars. Bone-grafting operations were possible two to three months after healing of the wound and the removal of all scar tissue rather than waiting six months or more, and the incidence of post-operative infection was minimal. This can be attributed to better and earlier initial surgery by well-trained surgeons, rapid evacuation, early closure of wounds, antibiotics, plasma and whole blood.

Eight thousand major amputations were treated in the five amputation centers; stumps were revised and concomitant wounds treated. Prostheses were fitted from the orthopaedic shop of the hospital after the stump had been prepared for fitting. With the aid of the Physical Therapy Department the patient was taught the use of the prosthesis and was rehabilitated with the aid of occupational therapy before discharge. All of this was the responsibility of the chief of the Amputation Service. Under the auspices of the National Research Council a prosthetic research project was initially set up by the Army in 1945 in which the Veterans'

Administration later shared. This project still continues. Some $15,000,000 has been expended to improve the prosthesis for the military and civilian amputee as well. Considerable improvement has been developed, particularly in the upper extremity prosthesis. The Navy and Army have each carried on their own research and development projects. The Army has developed a new hook and hand covered with a skin-appearing plastic along with an ingenious lever device which permits delivery of greater power than heretofore obtainable.

Orthopaedic surgery as we know it to-day had its birth in World War I and we might say became of age in the second world war. Many young men returned to civilian life from the Army well trained in bone and joint surgery by the able orthopaedic consultants and chiefs of orthopaedic services who served so well in the Medical Corps of the Army in World War II.

THE VETERANS' ADMINISTRATION HOSPITALS

A Review of their Contribution to Orthopaedic Surgery since 1946

PAUL MAGNUSON, CHICAGO, ILLINOIS

In the old days of the Veterans' Administration Medical Department specialists were created by edict: the manager of a hospital assigned a man to a speciality in which a specialist was needed. This did not involve particular consideration of such man's previous training or interest in that speciality, and certainly did not conform to any pattern that we now consider as adequate training.

On the introduction of the new medical program of the Veterans' Administration General Paul R. Hawley, then Chief Medical Director, called into consultation top bracket men in all the specialities of medicine and surgery. Dr Ralph Ghormley was the first Chief Consultant in orthopaedic surgery and he was succeeded by Dr Rex Diveley. This group was headed by Dr Elliott Cutler and each member was asked to recommend consultants in his own speciality in the different geographical branches of the Veterans' Administration. These men were known as branch consultants in their particular speciality. They in turn were asked to recommend individuals in their speciality to oversee that speciality in the various Veterans' Administration Hospitals, at that time numbering about 105.

In addition to these consultants the approved Medical Schools of the country were asked to staff, as far as possible from their faculties of Medicine, hospitals located in their immediate vicinity, and in this case the Professor of Orthopaedic Surgery was usually made Chief Consultant to that hospital in that speciality. He in turn was asked to staff that hospital with his junior men and establish residency training in orthopaedic surgery. This was done promptly and so effectively and the cases admitted to the hospital were distributed so well, according to the various specialities, that no conflict arose among the specialities.

Orthopaedic surgery was considered a speciality of surgery and in no case as far as I know was there any conflict between the Chief of Orthopaedic Surgery and anyone else as to the distribution of cases. All bone and joint work was referred to the orthopaedic department, and the residents in general surgery, on orders from this office, were rotated for a six months' tour of duty through the orthopaedic department. The residents in orthopaedic surgery were given a year in general surgery before being admitted to residency in orthopaedic surgery. This was done by me, over some protest, because I have had a sincere feeling all my professional life that trying to make a specialist out of a man who has just finished his internship is a very short-sighted policy for the speciality involved. We are all surgeons and surgical principles should be thoroughly understood from every standpoint before a man specializes. We should all be diagnosticians and if it were possible I would have every surgeon, be he orthopaedic or other, have a year's internship or junior residency in internal medicine before he took up any speciality.

With this background of supervision by the top orthopaedic surgeons of the country, there has been developed in the Veterans' Administration the finest and broadest training in

orthopaedic surgery that anybody could devise at this time. In the Veterans' Administration we can give only adult orthopaedic surgery. We have an agreement with the medical schools that after a year or two years of service as a resident in orthopaedic surgery in the Veterans' Administration a man may go to an orthopaedic hospital for a year's work for his training in children's orthopaedic surgery, and during that one year he will be paid by the Veterans' Administration. This arrangement provides two years of adult orthopaedic surgery with the Veterans' Administration and one year of children's orthopaedic surgery at a children's hospital under the supervision of the Professor of Orthopaedic Surgery in a medical school. Through the earnest and constant efforts of the teachers of orthopaedic surgery and the collaboration of the Academy of Orthopaedic Surgeons and the American Board of Orthopaedic Surgery this has worked out to the great advantage of the young men interested in this speciality. At this time, some five years after the start of the program, a number of the men have finished their residencies in the Veterans' Administration or elsewhere and are serving as Chiefs of Orthopaedic Surgery in our various hospitals.

In our smaller institutions of 200 to 300 beds we cannot carry on our residency training program but by agreement with the American Board of Orthopaedic Surgery young men may go to these smaller hospitals as ward surgeons in orthopaedic surgery, where they really act as chiefs of that speciality, for two years of practice in their speciality in order to complete their Board requirements. The Veterans' Administration has agreed to see that a Board Certified Consultant in orthopaedic surgery attends that hospital at least once a month to look over the young men's work and make an estimate of their honesty, the quality of their work in surgery and their judgment. In other words, they are these young men's sponsors for the two years of practice. All this is on a completely voluntary basis and it has nothing to do with the Military; it is run on the basis of the free, independent practice of medicine. We have no authority to hold any man anywhere.

We have taken the highest standards set by the medical profession as our own and we require the maintenance of these standards. There is no effort to send out orders from Washington as to how cases shall be treated, except to constantly call attention to the standards that have been set. This has offered a magnificent training to many young men, at the same time paying them a stipend: if they are veterans, $3,300 a year which does not include their board and room. When they become ward officers they become full-time employees of the Veterans' Administration at a grade which is determined by a Professional Standards Board and their previous record is one of the things that affects the grade under which they are employed. They are free to resign on the day after they are employed; they do not hold a commission; and they are allowed to consult with the doctors in their community if they are called, and to accept a fee for that service, but they cannot practice medicine in an office of their own or accept remuneration other than consultation fees.

In order to give the orthopaedic surgeon what he needed in the way of apparatus it was found necessary to establish brace shops in many of our hospitals. These brace shops are under the control of the Chief of Orthopaedic Surgery. Bracemakers have been trained in large numbers to satisfy the needs of the profession. In addition to this, thirty centers have been established for services to amputees. These centers are under the control of orthopaedic surgeons who have had special experience and have taken courses offered in various types of artificial limb making, fitting and design. The amputee is assigned to the Department of Orthopaedic Surgery. The Army, the American Academy of Orthopaedic Surgeons and the Veterans' Administration are collaborating in the preparation of an atlas of braces which is now nearing completion. This will cover the making, fitting and taking of molds for brace fittings. It will include specifications of materials and information as to where the bracemaker may purchase these materials from suppliers; and will serve as a means of bringing the bracemaker and the orthopaedic surgeon to an understanding so that they can both talk the same language from a thoroughly indexed catalog. So far as we know, this has never been

done and will be of great assistance to all concerned in the making and fitting of braces of the right kind to the disabled patient.

In addition to this the Veterans' Administration furnishes research laboratories to which the orthopaedic surgeons have free access and the help of many scientists in allied branches, such as chemistry, psychology and pathology. Many outstanding reports have come from these research laboratories which also act as a great stimulus for the young men who want to know why as well as how.

REHABILITATION

HOWARD RUSK, NEW YORK

[Rehabilitation owes more to Sir Robert Jones than to any other orthopaedic surgeon. It was his warm sympathy for the disabled and his amazing practicality which started the great movement in England during the first world war. To quote his own words, already cited in this paper, " My feeling is that the heroic spirit that sent our beloved dead to their end, should be reflected in an equally heroic effort on our part to make and keep the nation efficient."

At this time, we must not forget the name of that remarkable man, Konrad Biesalski, who in 1914 inaugurated a program for Germany's war cripples similar to Sir Robert Jones's in England. During the interval between the two world wars rehabilitation flagged, but during the second world war it sprang into new life, in England largely under the inspiration of our distinguished editor, Sir Reginald Watson-Jones; in America under the guidance of Dr Howard Rusk, who by virtue of his achievements has been made the first Professor of Rehabilitation in America at the New York University Medical School—L. M.]

Without doubt much of the present growth of interest in extending rehabilitation opportunities and services to the handicapped has resulted both directly and indirectly from war. Such advances, however, are not entirely due to the impetus of war, for the growth of rehabilitation opportunities and services to the handicapped is a part of a total pattern of an expanding national and community consciousness of social welfare which is reflected in similar advances in all education, health and social services.

Immediately after World War I, as to-day, there was a developing interest in increasing rehabilitation opportunities for the physically disabled. Unfortunately much of this interest died in the years between the wars. From it, however, did come some pioneer institutions and some needed legislation such as the Federal-State vocational rehabilitation programs. Even before this workmen's compensation laws enacted in several states prior to 1920 had given official recognition to the growing belief in the responsibility of society for the welfare of injured workmen and revealed the necessity for further legislation designed to restore to disabled persons the earning power lost as a result of industrial accidents.

World War I created a problem of national importance in that the large number of disabled veterans had a clear moral claim upon the nation and the government in whose behalf they had sustained their injuries. In recognition of their needs Congress passed the Smith-Sears Soldiers' Rehabilitation Act of June 1918. This was followed in 1920 by the Fess-Kenyon Act providing for " the vocational rehabilitation of persons disabled in industry or otherwise and their return to civil employment." The primary feature of both of these acts was the provision of vocational counselling and training for the disabled person. No provision was made for physical restoration or reducing the physical disabilities of the trainees. Such restrictions made it impossible for the state vocational rehabilitation programs operating under the Federal Office of Vocational Rehabilitation to give adequate service to their clients. Until medical services were made a part of the program by the Barden-La Follette Amendment of 1943, in twenty-three years only 210,000 persons were rehabilitated, although over a million persons were in need of such aid at any given time during that period.

Under the Walsh-Clark-Rankin Act of March 1943 disabled veterans of World War II were provided with vocational counselling, vocational training and subsistence payments while undergoing such training. The medical and physical rehabilitation aspects of the

veterans' program are provided by the Physical Medicine Rehabilitation Services established in all Veterans' Administration hospitals. Under these programs the disabled veteran is receiving the full advantages of all modern techniques and methods of rehabilitation.

Although the focus of attention has been centered on the disabled veterans, the extent of disability among our civilian population is far greater. There were 20,500 amputations during World War II among military personnel, but over 120,000 civilians suffered major amputations during the same period. Some 265,000 men were permanently disabled as a result of combat injuries during the war, but 1,250,000 civilians were permanently disabled by disease and accidents in the same period. There are some 23,000,000 persons in the United States who are handicapped to some extent by disease, accident, maladjustment or war. Not all of these would need rehabilitation, but it is estimated that over 2,000,000 persons need such services if they are to be employable. Through the efforts of the Baruch Committee on Physical Medicine and Rehabilitation, the National Foundation for Infantile Paralysis, the National Society for Crippled Children and Adults, and other voluntary and public agencies, increasing attention is being devoted to the provision of rehabilitation—the third phase of medicine which takes the patient from the bed to the job. One of the most significant recent developments is the increase in training in physical medicine and rehabilitation given to both undergraduate and postgraduate students. The American Board of Physical Medicine and Rehabilitation has been granted speciality status and a section on Physical Medicine and Rehabilitation has been created in the American Medical Association.

With the growing incidence of chronic disease and its resultant physical disability, it can be expected that the prevalence of physical disability in this nation will increase rather than decrease in the future. A thousand years ago the average length of life was twenty-five years; at the turn of the century it was forty-nine; to-day it is sixty-six and five-tenths. In 1900 one person in twenty-five was sixty-five years of age or older; it is estimated that in 1980 the ratio will be one in ten.

Lacking specific measures for the cure of many of the chronic diseases, medicine must look to rehabilitation to teach those afflicted with chronic disability to live and to work as effectively as possible with what they have left. Until medicine finds the specific answers to the problems of the diseases of the heart and circulation, rheumatic fever and arthritis, cerebral palsy, multiple sclerosis, poliomyelitis and other crippling diseases, it must utilize the techniques of physical rehabilitation, vocational guidance, psychology, social service and other ancillary specialities of rehabilitation to teach the disabled to live within the limits of their disabilities but to the hilt of their capabilities.

THE COMMITTEE ON ARTIFICIAL LIMBS OF THE NATIONAL RESEARCH COUNCIL

RUFUS ALDREDGE, NEW ORLEANS, LOUISIANA

During World War II, at the request of the Surgeon-General of the Army, the Committee on Prosthetic Devices was set up by the National Research Council to study artificial limbs and to carry out research work to the end of improving prostheses in general. The Committee was composed of several orthopaedic surgeons and several physicists, engineers and other scientists, who immediately set to work to reach some common point of agreement as to what needed to be done in completing the great task ahead. Together they visited the various war-time amputation centers, inspecting the amputation problems first hand from the aspects of the requirements of the patient, of the individual amputation stumps, as well as the prosthetic needs and shortcomings with a view to proceeding with research and development to eventually improve the prosthetic appliance.

After some time and effort the committee decided that the best approach would be to develop contracts with various universities, industries and individuals throughout the country

who would work on special problems. As a result, many different groups of men throughout the country became interested and carried out research and development work in the various phases of the amputation problem with regard to the prosthesis.

Early in 1946 a group of orthopaedic surgeons, engineers and physicists were sent to Europe to visit the various leading European Centers in an effort to determine if any new or improved methods regarding amputations and artificial limbs were being used which were not already known about. Of outstanding interest to the research effort reported by the European Commission was the development of the cineplastic method for upper extremity amputations and the suction socket prosthesis for the lower extremity amputations, particularly amputations above the knee. The Committee on Artificial Limbs immediately set to work with research and development projects on the suction socket prosthesis and the cineplastic method and as a result, after four years of trial, there has been great improvement in the cineplastic prosthesis, and the suction socket prosthesis for above the knee amputations has been tested and proved to be a great advance.

There have been many other contributions to the entire problem of amputations and artificial limbs, including basic and fundamental research work on anatomy, physiology and function of the normal muscles of the extremities, as well as those of amputated extremities. The results of this work have been used by all of the research and developmental workers as a basis upon which to guide their research problems in artificial limbs.

The work of the original committee is still under way in co-operation with the Veterans' Administration, and the new and improved products which have been developed by the individual researchers have been thoroughly tested on selected amputee subjects before their release for general use. Some of the newly developed prosthetic aids are still under testing and development at various centers throughout the country.

SUMMARY

In the welter of details contained in the preceding pages the reader has, I trust, perceived certain broad shining pathways leading towards our orthopaedic lode-star, the adequate treatment of all the crippled and disabled of our community—adults and children, rich and poor. These are, as I see them, four in number: first, the emergence of our speciality from a tiny beginning, against the opposition of general surgery, to the position of an accepted branch of surgery secure in the support of all the branches of medical science. Second, the development not only of technical skill but of a humanitarian spirit which has resulted in the adequate care of the crippled child and, to a lesser degree, of the crippled adult. Third, the growth of educational facilities for undergraduate and postgraduate instruction and for research. Finally, the integration of orthopaedic surgery with all those progressive elements in the community which aim to democratize our efforts on behalf of the disabled.

This paper could not have been written without the co-operation of many friends to whom I gratefully acknowledge my indebtedness. My thanks are due particularly to the following:

For contributions: Dr LeRoy Abbott, Dr Rufus Aldredge, Dr Carl Badgley, Dr Joseph Barr, Dr Harry C. Blair, Dr Walter P. Blount, Dr Aaron Bodansky, Dr Joseph A. Boyes, Dr Jospeh Buchman, Dr Michael Burman, Dr John Cobb, Dr Edward L. Compere, Miss Dorothy Ducas, Dr G. W. N. Eggers, Dr Jospeh Freiberg, Dr Ralph Ghormley, Dr H. Bruce Gill, Dr Joel E. Goldthwait, Dr William T. Green, Dr Verne T. Inman, Dr Henry Jaffe, Dr Abel Kenin, Dr Norman Kirk, Dr Hiram Kite, Dr Barmard Kleiger, Dr H. R. McCarroll, Dr Henry Milch, Dr J. T. Nicholson, Dr Robert G. Packard, Dr Charles W. Peabody, Dr Winthrop Phelps, Dr Howard Rusk, Dr A. R. Shands, Dr John A. Siegling, Dr Otto Steinbrocker, Dr Arthur Steindler, Dr Charles Sutro, Dr Vernon P. Thompson, Dr Allen F. Voshell, Dr Samuel M. Wishik.

For the loan or donation of photographs: Mrs Fred Albee, Dr Rodney F. Atsatt, Miss Florence Daland, Dr G. W. N. Eggers, Dr Jospeh Freiberg, Dr William Green, Dr Samuel Kleinberg, Dr H. R. McCarroll, Dr Paul Magnuson, Dr Jesse T. Nicholson, Dr Edwin W. Ryerson, Dr A. R. Shands, Dr Alan DeForest Smith, Dr James Speed.

To my son-in-law, Lloyd McKean, for his symbolic drawing of the growth of American Orthopaedic Surgery.

For help in preparation of the manuscript: Miss Amelia Mater, Mrs Esther Ney.

For advice and encouragement: Dr William Rogers and Miss Florence Daland.

REFERENCES

Part I

BRACKETT, E. G., (1891): Atrophy in Joint Disease. Transactions of the American Orthopedic Association, **4,** 61.

BRACKETT, E. G. (1897): Gluteal Bursitis. Transactions of the American Orthopedic Association, **10,** 123.

BRADFORD, E. H. (1889): Treatment of Club-foot. Transactions of the American Orthopedic Association, **1,** 89.

BRADFORD, E. H. (1895): Slipping Patella. Transactions of the American Orthopedic Association, **8,** 228.

BRADFORD, E. H. (1894, 1900, 1902): Congenital Dislocation of the Hip Joint. Transactions of the American Orthopedic Association, **7,** 88; **13,** 124; and **15,** 284.

BRADFORD, E. H. (1902): Shoe Deformities. Transactions of the American Orthopedic Association, **15,** 321.

BRADFORD, E. H., and STONE, J. S. (1899): The Seating of School Children. Transactions of the American Orthopedic Association, **12,** 170.

BRYANT, J. D. (1891): Ten Cases of Excision of the Knee Joint for Disease, and their Lessons. Transactions of the American Orthopedic Association, **4,** 314.

BROWN, D. (1894): A Case of Ankylosis of the Jaw in a Child. Transactions of the American Orthopedic Association, **7,** 306.

DANE, J. (1902): Remarks on Arthrodesis of the Ankle for Infantile Paralysis. Transactions of the American Orthopedic Association, **15,** 29.

DAVIS, G. G. (1900): An Operation for Ununited Intracapsular Fracture of the Neck of the Femur. Transactions of the American Orthopedic Association. **13,** 134.

FOSTER, C. C. (1891): Extension in Bed in the Treatment of Caries of the Spine. Transactions of the American Orthopedic Association, **4,** 258.

GIBNEY, V. P. (1894): The Correction of the Deformity of Hip-Disease. Transactions of the American Orthopedic Association, **7,** 190.

GILLETTE, A. J. (1898): An Operation for Ununited Fracture of the Neck of the Femur. Transactions of the American Orthopedic Association, **11,** 241.

GOLDTHWAIT, J. E. (1892): Joint Lesions due to Spinal Disease. Transactions of the American Orthopedic Association, **5,** 84.

GOLDTHWAIT, J. E. (1894): Anterior Transverse Arch Proven by Frozen Section. Transactions of the American Orthopedic Association, **7,** 82.

GOLDTHWAIT, J. E. (1895): Tendon Transplantation in the Treatment of Paralytic Deformities. Transactions of the American Orthopedic Association, **8,** 20.

GOLDTHWAIT, J. E. (1900): Knee-joint Surgery for Non-tubercular Conditions. Boston Medical and Surgical Journal, **143,** 286.

HADRA, B. E. (1891): Wiring the Spinous Processes in Pott's Disease. Transactions of the American Orthopedic Association, **4,** 206.

HODGEN, H. (1892): Peripheral Neuritis and Scapular Brace. Transactions of the American Orthopedic Association, **5,** 148.

JONES, C. N. D. (1889): Etiology and Pathology of Rachitic Deformity. Transactions of the American Orthopedic Association, **1,** 242.

JUDSON, A. B. (1891): President's Address: Orthopedic Surgery as a Speciality. Transactions of the American Orthopedic Association, **4,** 1.

KETCH, S. (1897): President's Address: Summary of Papers of its First Ten Years. Transactions of the American Orthopedic Association, **10,** 1.

LORENZ, A. (1894): The operative Treatment of Congenital Dislocation of the Hip Joint. Transactions of the American Orthopedic Association, **7,** 99.

LORENZ, A. (1896): Cure of Congenital Luxation of the Hip by Bloodless Reduction and Weighting. Transactions of the American Orthopedic Association, **9,** 254.

LOVETT, R. W. (1897): Spondylolisthesis with Description of a Case. Transactions of the American Orthopedic Association, **10,** 20.

LOVETT, R. W. (1897): Late Excision of the Hip. Transactions of the American Orthopedic Association, **10,** 55.

LOVETT, R. W. (1898): President's Address: Pathology in its Relation to Orthopedic Surgery. Transactions of the American Orthopedic Association, **11,** 1.

LOVETT, R. W. (1900): The Mechanics of Lateral Curvature of the Spine. Transactions of the American Orthopedic Association, **13,** 251.

LOVETT, R. W., and COTTON, F. J. (1898): Some Practical Points in the Anatomy of the Foot. Transactions of the American Orthopedic Association, **11,** 298.
LOVETT, R. W., and GOLDTHWAIT, J. E. (1889): The Abscesses of Hip Disease. Transactions of the American Orthopedic Association, **2,** 82.
MCKENZIE, B. E. (1901): Neurosis as seen in Orthopedic Practice. Transactions of the American Orthopedic Association, **14,** 24.
MOORE, J. E. (1892): A Report of Six Cases of Excision of the Knee Joint. Transactions of the American Orthopedic Association, **5,** 140.
MOORE, J. E. (1895): Pigeon-toe. Transactions of the American Orthopedic Association, **8,** 254.
NICHOLS, E. H. (1898): Tuberculosis of Bones and Joints. Transactions of the American Orthopedic Association, **11,** 353.
PACKARD, G. B. (1898): Observations upon Tubercular Joint Disease in Colorado. Transactions of the American Orthopedic Association, **11,** 164.
PARK, R. (1895): On the Deformities and Malformations Resulting from Acute Infections in Bone. Transactions of the American Orthopedic Association, **8,** 102.
PHELPS, A. M. (1894): President's Address: The Influence of Surgical Bacteriology and Modern Pathology upon Orthopedic Surgery. Transactions of the American Orthopedic Association, **7,** 31.
PLIMPTON, W. O. (1895): Excision of Knee as an Orthopedic Procedure. Transactions of the American Orthopedic Association, **8,** 187.
SAYRE, R. H. (1889): Excision of the Hip Joint. Transactions of the American Orthopedic Association, **2,** 153.
SAYRE, R. H. (1893): A Contribution to the Study of Club-hand. Transactions of the American Orthopedic Association, **6,** 208.
SHERMAN, H. M. (1893): The Question of Excision of the Hip Joint for Tubercular Disease and the Results of the Operation. Transactions of the American Orthopedic Association, **6,** 120.
SHERMAN, H. M. (1900): President's Address: Transactions of the American Orthopedic Association, **13,** 1.
STEELE, A. J. (1893): President's Address: The Embodiment of an Idea. Transactions of the American Orthopedic Association, **6,** 7.
STEELE, A. J. (1898): Hallux Valgus Extremus. Transactions of the American Orthopedic Association, **11,** 17.
TAYLOR, H. L. (1894): Infantile Scorbutus and its Relation to Orthopedic Practice. Transactions of the American Orthopedic Association, **7,** 129.
TAYLOR, H. L. (1899): Enlargement of Tibial Tubercles. Transactions of the American Orthopedic Association, **12,** 138.
THOMSON, C. E. (1901): Operative Case of Intracapsular Fracture of the Hip. Transactions of the American Orthopedic Association, **14,** 361.
TOWNSEND, W. R. (1889): Acute Arthritis of Infants. Transactions of the American Orthopedic Association, **2,** 260.
TOWNSEND, W. R. (1900): Tendon Transplantation in the Treatment of Deformities of the Hand. Transactions of the American Orthopedic Association, **13,** 193.
VANCE, AP M. (1889): Femoral Osteotomy for the Correction of Deformity Resulting from Hip-joint Disease. Transactions of the American Orthopedic Association, **1,** 149.
WEIGEL, L. A. (1899): The Diagnostic Value of Radiography in Orthopedic and General Surgery. Transactions of the American Orthopedic Association, **12,** 76.
WHITMAN, R. (1889): Observations on Seventy-five Cases of Flat-foot with Particular Reference to the Treatment. Transactions of the American Orthopedic Association, **1,** 122.
WHITMAN, R. (1894): Observations on Bending of the Neck of the Femur in Adolescence. Transactions of the American Orthopedic Association, **7,** 270.
WHITMAN, R. (1895): A Study of the Weak Foot. Transactions of the American Orthopedic Association, **8,** 42.
WHITMAN, R. (1896): President's Address: A Definition of the Scope of Orthopedic Surgery. Transactions of the American Orthopedic Association, **9,** 1.
WHITMAN, R. (1897): Further Observations on Fracture of the Neck of the Femur in Childhood. Transactions of the American Orthopedic Association, **10,** 216.
WHITMAN, R. (1898): Observations on Morton's Painful Affection of the Fourth Metatarso-phalangeal Articulation. Transactions of the American Orthopedic Association, **11,** 34.
WILLARD, DE F. (1889): Osteotomy for Anterior Curvatures of the Leg. Transactions of the American Orthopedic Association, **1,** 138.
WILLARD, DE F. (1893): Operative Treatment of Knee-Joint Disease. Transactions of the American Orthopedic Association, **6,** 23.
WILLARD, DE F. (1900): President's Address: Transactions of the American Orthopedic Association, **3,** 1.
WILSON, H. A. (1902): President's Address: The Advance of Orthopedic Surgery. Transactions of the American Orthopedic Association, **15,** 1.

Part III

ABBOTT, E. G. (1917): Scoliosis. American Journal of Orthopedic Surgery, **15,** 26; **15,** 108; **15,** 172; **15,** 243; **15,** 362.

ALBEE, F. (1911): Transplantation of a Portion of the Tibia into the Spine for Pott's Disease. Journal of the American Medical Association, **57,** 885.

ALBEE, F. (1913): An Experimental Study of Bone Growth and the Spinal Bone Transplant. Journal of the American Medical Association, **60,** 1044.

ALBEE, F. (1914): The Inlay Bone Graft Growth in Fresh Fractures. New York Medical Journal, **99,** 1020.

ALBEE, F. (1916): A Statistical Study of 539 Cases of Pott's Disease treated by the Bone Graft. American Journal of Orthopedic Surgery, **14,** 134

ALLISON, N. (1905): A Study of the Anatomy of Congenital Dislocation of the Hip after Manipulative Reduction. American Journal of Orthopedic Surgery, **3,** 157.

ALLISON, N. (1915): Tuberculosis of the Hip. American Journal of Orthopedic Surgery, **12,** 623.

ALLISON, N., and BROOKS, B. (1918): Arthroplasty: Experimental and Clinical Methods. American Journal of Orthopedic Surgery, **16,** 83.

ALLISON, N., and MOODY, E. F. (1915): Osteochondritis Deformans Juvenilis (Perthes Disease). American Journal of Orthopedic Surgery, **13,** 197.

ALLISON, N., and SCHWAB, S. I. (1910): Muscle Group Isolation and Nerve Anastomosis in the Treatment of the Paralysis of the Extremities. American Journal of Orthopedic Surgery, **8,** 95.

ARNOLD, E. H. (1916): Fixation of the Sacrum. American Journal of Orthopedic Surgery, **14,** 574.

BAER, W. S. (1909): A Preliminary Report of the Use of Animal Membrane in Producing Mobility in Ankylosed Joints. American Journal of Orthopedic Surgery, **7,** 1.

BAER, W. S. (1918): Arthroplasty with the Aid of Animal Membrane. American Journal of Orthopedic Surgery, **16,** 94.

BAKER, E. M. (1918): Opportunities for Social Service in an Orthopaedic Clinic. American Journal of Orthopedic Surgery, **16,** 34.

BARRIE, G. (1918): Hemorrhagic Osteomyelitis and Sarcoma in Bone. American Journal of Orthopedic Surgery, **16,** 392.

BARTOW, B., and PLUMMER, W. W. (1911, 1913, 1916): The Use of Intra-articular Silk Ligaments for Fixation of Loose Joints in the Residual Paralysis of Anterior Poliomyelitis. American Journal of Orthopedic Surgery, **9,** 65; **10,** 499; **14,** 594.

BLANCHARD, W. (1906): The Exceptional Rachitic Distortions of the Legs. American Journal of Orthopedic Surgery, **4,** 207.

BLANCHARD, W., and PARKER, C. A. (1915): A Resection of the Transverse Process of the Fifth Lumbar Vertebra for the Relief of Painful Back. American Journal of Orthopedic Surgery, **13,** 250.

BLODGETT, W. E. (1905): Congenital Luxation of the Head of the Radius. American Journal of Orthopedic Surgery, **3,** 253.

BRACKETT, E. G. (1905): President's Address. American Journal of Orthopedic Surgery, **3,** 1.

BRACKETT, E. G. (1910): Study of the Relation Between Clinical Evidence and Pathological Conditions in Spinal Caries. American Journal of Orthopedic Surgery, **8,** 362.

BRACKETT, E. G. (1915): Operative Treatment of Osteoarthritis, American Journal of Orthopedic Surgery, **13,** 46.

BRACKETT, E. G., and HALL, C. L. (1917): Osteochondritis Dissecans. American Journal of Orthopedic Surgery, **15,** 79.

BRICKNER, W. M. (1912): Abduction Treatment of Shoulder. American Journal of Surgery, **26,** 196; American Journal of the Medical Sciences, **149,** 351; Medical Record, **87,** 15.

BUCHOLZ, C. H. (1914): Further Studies of the So-called "Sciatic Scoliosis." American Journal of Orthopedic Surgery, **12,** 90.

BUCHOLZ, C. H. and OSGOOD, R. B. (1914): A Frame for Standardizing Photographic Records of Scoliosis. American Journal of Orthopaedic Surgery, **12,** 77.

CAMPBELL, W. C. (1917): An Analysis of Fifty-one Bone and Joint Affections Treated by Heliotherapy, with Special Reference to Tuberculosis. American Journal of Orthopedic Surgery, **15,** 1.

CODIVILLA, A. (1903): On the Means of Lengthening, in the Lower Limbs, the Muscles and Tissues which are Shortened through Deformity. American Journal of Orthopedic Surgery, **2,** 353.

CODMAN, E. A. (1906): On Stiff and Painful Shoulders. Boston Medical and Surgical Journal, **154,** 613.

CODMAN, E. A. (1934): The Shoulder. Boston: Privately printed.

COON, C. E. (1911): Dyschondroplasia. American Journal of Orthopedic Surgery, **9,** 604.

COTTON, F. J. (1911): Artificial Impact in Hip Fracture. American Journal of Orthopedic Surgery, **8,** 680.

COTTON, F. J., and HENDERSON, F. F. (1916): Results of Fracture of the Os Calcis. American Journal of Orthopedic Surgery, **14,** 290.

DAVIS, G. G. (1905): Multiple Cancellous Exostoses. American Journal of Orthopedic Surgery, **3,** 234.
DAVIS, G. G. (1913): The Treatment of Hollow Foot (Pes Cavus). American Journal of Orthopedic Surgery, **11,** 23.
DAVIS, G. G. (1914): The Education of Crippled Children. American Journal of Orthopedic Surgery, **12,** 1.
DUNLOP, J. (1907): Further Studies of the Relaxation of the Sacro-iliac Synchondroses. American Journal of Orthopedic Surgery, **5,** 101.
DUNLOP, J. (1911) The Adolescent Tibial Tubercle. An Anatomical and Pathological Study. American Journal of Orthopedic Surgery, **9,** 313.
ELLIOTT, G. R. (1905): Rigid Spine. American Journal of Orthopedic Surgery. **3,** 303.
ELLIOTT, G. R. (1912): An X-ray Study of Gastro-intestinal Findings in Multiple Arthritis. American Journal of Orthopedic Surgery, **10,** 56.
ELY, L. W. (1911): Joint Tuberculosis in Children. American Journal of Orthopedic Surgery, **9,** 31.
ELY, L. W. (1912): The Etiology of Chronic Non-tuberculous Arthritis. American Journal of Orthopedic Surgery, **10,** 171.
ELY, L. W. (1913): The Pathology of Tabetic Arthropathy: Preliminary Study of Two Cases. American Journal of Orthopedic Surgery, **11,** 404.
ERLACHER, P. (1915): Direct and Muscular Neurotization of Paralyzed Muscles. American Journal of Orthopedic Surgery, **3,** 22.
FEISS, H. O. (1906, 1907): The Mechanics of Lateral Curvature. American Journal of Orthopedic Surgery, **4,** 37; **4,** 323; **5,** 152.
FISHER, A. L. (1916): Torticollis—A Review. American Journal of Orthopedic Surgery, **14,** 669.
FÖRSTER, O. (1908): Über eine neue operative Methode der Behandlung spastischer Lähmungen mittels Resektion hinterer Rückenmarkswurzeln. Zeitschrift für Orthopädische Chirurgie, **22,** 203.
FREIBERG, A. H. (1905): Coxa Vara Adolescentium and Osteoarthritis Deformans Coxae. American Journal of Orthopedic Surgery, **3,** 6.
FREIBERG, A. H. (1913): Corrective Jackets in the Treatment of Structural Scoliosis with Especial Reference to Mensuration and Record. American Journal of Orthopedic Surgery, **11,** 29.
FREIBERG, A. H. (1914): Infraction of the Second Metatarsal Bone. Surgery, Gynecology and Obstetrics, **19,** 191.
FREIBERG, A. H. (1914): Editorial: Scoliosis. American Journal of Orthopedic Surgery, **12,** 183.
FREIBERG, A. H. (1937): Orthopedic Surgery in the Light of Its Evolution. Journal of Bone and Joint Surgery, **19,** 279.
FREIBERG, A. H., SILVER, D., and OSGOOD, R. B. (1914): Report of the Committee on the Treatment of Structural Scoliosis to the American Orthopedic Association. American Journal of Orthopedic Surgery, **12,** 5.
FREIBERG, A. H., SILVER, D., and OSGOOD, R. B. (1915): Second Report of the Committee on the Treatment of Structural Scoliosis to the American Orthopedic Association. American Journal of Orthopedic Surgery, **13,** 6.
FREIBERG, A. H., and WOOLLEY, P. G. (1910): Osteochondritis Dissecans: Concerning its Nature and Relation to Formation of Joint Mice. American Journal of Orthopedic Surgery, **8,** 477.
GAENSLEN, F. J. (1915): Osteitis Deformans (Paget's Disease). American Journal of Orthopedic Surgery, **13,** 96.
GALLIE, W. E. (1914): The History of a Bone Graft. American Journal of Orthopedic Surgery, **12,** 201.
GALLIE, W. E. (1917): How Canada is Caring for her Crippled Soldiers. American Journal of Orthopedic Surgery, **15,** 547. (Unsigned Article.)
GALLIE, W. E., and LE MESURIER, A. B. (1922): A Clinical and Experimental Study of the Free Transplantation of Fascia and Tendon. Journal of Bone and Joint Surgery, **4,** 600.
GEIST, E. S. (1907): Chondrodystrophia Foetalis. American Journal of Orthopedic Surgery, **5,** 240.
GIBNEY, V. P. (1905): A Report of the Adult Ward of the Hospital for the Ruptured and Crippled for the First Two Years Ending March 1, 1905. American Journal of Orthopedic Surgery, **3,** 178.
GILLETTE, A. J. (1909): Editorial. American Journal of Orthopedic Surgery, **6,** 723.
GOLDTHWAIT, J. E. (1905, 1907, 1911): Anatomic Explanation of Weak or Painful Back. Boston Medical and Surgical Journal, **152,** 280. Journal of the American Medical Association, **49,** 768. Boston Medical and Surgical Journal, **164,** 365.
GOLDTHWAIT, J. E. (1909): The Relation of Posture to Human Efficiency and the Influence of Poise Upon the Support and Function of the Viscera. American Journal of Orthopedic Surgery, **7,** 371.
GOLDTHWAIT, J. E. (1916): The Opportunity for the Orthopedist in Preventive Medicine through Eductaional Work on Posture. American Journal of Orthopedic Surgery, **14,** 443.
HAAS, S. L. (1917): Relation of the Blood Supply to the Longitudinal Growth of Bone. American Journal of Orthopedic Surgery, **15,** 157, 305.
HAMMOND, R. (1911): A Roentgenologic Study of some Brittle Bones. American Journal of Orthopedic Surgery, **9,** 615.

HARTWELL, J. B. (1916): Fractures of the Spine without Paraplegia. American Journal of Orthopedic Surgery, **14,** 82.
HAWLEY, G. W. (1917): Bone and Joint Infections Treated by the Carrel Technique. American Journal of Orthopedic Surgery, **15,** 586.
HENDERSON, M. S. (1914): Transplantation of Bone in Ununited Fractures. Lancet, **34,** 615.
HENDERSON, M. S. (1917): Osteochondromatosis of the Knee Joint. American Journal of Orthopedic Surgery, **15,** 351.
HENDERSON, M. S. (1918): What are the Real Results of Arthroplasty ? American Journal of Orthopedic Surgery, **16,** 30.
HIBBS, R. A. (1911): An Operation for Progressive Spinal Deformities. New York Medical Journal, **93,** 1013.
HOKE, M. (1903): Lateral Curvature Rib Resection Operation Both Sides. American Journal of Orthopedic Surgery, **1,** 168.
HOKE, M. (1911): An Operative Plan for the Correction of Relapsed and Untreated Talipes Equinovarus. American Journal of Orthopedic Surgery, **9,** 379.
HOKE, M. (1921): An Operation for Stabilizing Paralytic Feet. Journal of Orthopedic Surgery, **N.S. 3,** 494.
HONEIJ, J. A. (1917): Bone Changes in Leprosy. American Journal of Roentgenology, **4,** 494.
HORWITZ, A. E. (1908): Congenital Elevation of the Scapula—Sprengel's Deformity. American Journal of Orthopedic Surgery, **6,** 260.
HORWITZ, A. E. (1909): Adolescent Rachitis. Etiology and Pathology. American Journal of Orthopedic Surgery, **7,** 199.
HUNKIN, S. J. (1913): Experience with Foerster's Operation. American Journal of Orthopedic Surgery, **11,** 207.
JAEGER, C. H. (1908): Gonorrhoeal Exostoses of the Os Calcis. American Journal of Orthopedic Surgery, **5,** 304.
JONES, R. (1907): An Operation for Paralytic Calcaneo-cavus. American Journal of Orthopedic Surgery, **5,** 371.
JONES, R. (1913): An Orthopedic View of the Treatment of Fractures. American Journal of Orthopedic Surgery, **11,** 314.
JONES, R. (1918): The Problem of the Disabled. American Journal of Orthopedic Surgery, **16,** 273.
JONES, S. F. (1911): Bilateral Congenital Dislocation of the Lower End of the Ulna. American Journal of Orthopedic Surgery, **9,** 199.
LANGE, F. (1910): The Orthopedic Treatment of Spinal Paralysis. American Journal of Orthopedic Surgery, **8,** 8.
LANGE, F. (1910): Support for the Spondylitic Spine by Means of Buried Steel Bars, Attached to the Vertebrae. American Journal of Orthopaedic Surgery, **8,** 344.
LEGG, A. T. (1908): The Cause of Atrophy in Joint Disease. American Journal of Orthopedic Surgery, **6,** 84.
LOVETT, R. W. (1906): Intermittent Limping (Myasthenia Angio-Sclerotica). American Journal of Orthopedic Surgery, **4,** 120.
LOVETT, R. W. (1918): The Problem of the Reconstruction and Re-education of the Disabled Soldier. Surgery, Gynecology and Obstetrics, **27,** 169.
LOVETT, R. W., and MARTIN, E. G. (1916): The Spring Balance Muscle Test. American Journal of Orthopedic Surgery, **14,** 415.
LOW, H. C. (1914): A Study of the Scope and Efficiency of a Large Orthopedic Clinic. American Journal of Orthopedic Surgery, **12,** 396.
MAYER, L. (1916): The Physiological Method of Tendon Transplantation. Surgery, Gynecology and Obstetrics, **22,** 182; **22,** 298; **22,** 472.
MAYER, L., and WEHNER, E. (1914): An Experimental Study of Osteogenesis. American Journal of Orthopedic Surgery, **12,** 213.
MCMURTRIE, D. C. (1911): The Care of Crippled Children in the United States. American Journal of Orthopedic Surgery, **9,** 527.
MEISENBACH, R. O. (1910): A Consideration of the Chemical and Mechanical Stimulation of Bone with Reference to the Epiphysial and Diaphysial Lines. American Journal of Orthopedic Surgery, **8,** 28.
MEISENBACH, R. O. (1911): A Pelvi-thoracic Triangle as a Means of Recording Spinal Lateral Curvature. A Scoliometer. American Journal of Orthopedic Surgery, **9,** 690.
MURPHY, J. B. (1912): Contribution to the Surgery of Bones, Joints and Tendons. Journal of the American Medical Association, **58,** 985.
NATHAN, P. W. (1906): Differential Diagnosis of Arthritis. American Journal of the Medical Sciences, **132,** 857.
NATHAN, P. W., and STRANG, W. W. (1909): The Joint Cartilage in its Relation to Joint Pathology. American Journal of Orthopedic Surgery, **7,** 85.

OBER, F. (1916): An Operation for Congenital Equinovarus Deformity. Journal of the American Medical Association, **65,** 621.
ORR, H. W. (1911): Reasons for the State Care of the Crippled and Deformed. American Journal of Orthopedic Surgery, **9,** 218.
OSGOOD, R. B. (1903): The Value of X-ray Negatives in the Study of Orthopedic Pathology. American Journal of Orthopedic Surgery, **2,** 390.
OSGOOD, R. B. (1907): The Comparative Strength of the Adductor and Abductor Groups in the Foot. American Journal of Orthopedic Surgery, **5,** 298.
PAINTER, C. F. (1913): The Development of Orthopedic Teaching in America. American Journal of Orthopedic Surgery, **11,** 301.
PAINTER, C. F., and CLARKE, J. D. (1908): Myositis Ossificans. American Journal of Orthopedic Surgery, **6,** 626.
PAINTER, C. F., and ROGERS, M. H. (1907): Neoplasms and their Relations to Orthopedic Surgery. American Journal of Orthopedic Surgery, **5,** 129.
PECKHAM, F. E. (1909): The Treatment of some Types of Rheumatoid Arthritis. American Journal of Orthopedic Surgery, **6,** 702.
PECKHAM, F. E. (1912): The Abdomen. An important Factor in Chronic Joint Affections. American Journal of Orthopedic Surgery, **10,** 80.
PORTER, J. L. (1918): Orthopedic Surgery and the War. American Journal of Orthopedic Surgery, **16,** 413.
PREISER, G. (1912): Static Joint Diseases. American Journal of Orthopedic Surgery, **10,** 100.
RIDLON, J. (1907): A Preliminary Report upon Ten Cases of Chronic Joint Disease, Treated by Tuberculin Injections by Wright's Method. American Journal of Orthopedic Surgery, **5,** 14.
ROGERS, M. H. (1914): Tuberculosis of the Knee Joint in Adults: Prognosis and Treatment. American Journal of Orthopedic Surgery, **12,** 589.
RUGH, J. T. (1916): Bone-grafting for Spinal Conditions. American Journal of Orthopedic Surgery, **14,** 71.
RYERSON, E. W. (1914): Pott's Disease, Albee's Bone Grafting Operation. Results in a Series of Twenty-six Cases Operated more than Six Months Ago. American Journal of Orthopedic Surgery, **12,** 259.
SAYRE, R. H. (1904): President's Address. American Journal of Orthopedic Surgery, **2,** 1.
SCHLATTER, C. (1903): Verletzungen des schnabel-formigen Fortsatzes oberen Tibiaepiphyse. Beiträge zur klinischen Chirurgie, **38,** 874.
SEVER, J. W. (1916): Obstetrical Paralysis—an Orthopedic Problem. American Journal of Orthopedic Surgery, **14,** 456.
SILVER, D. (1906): An Experimental Study of the Influence of Necrosis, Produced by Sutures, in Tendon Suture and Transplantation. American Journal of Orthopedic Surgery, **4,** 218.
SILVER, D. (1911): The So-called Benign Cyst of the Bones. American Journal of Orthopedic Surgery, **9,** 563.
SMITH-PETERSEN, M. N. (1917): A New Supra-articular Subperiosteal Approach to the Hip Joint. American Journal of Orthopedic Surgery, **15,** 592.
STARR, C. L. (1918): The Role of Orthopedic Surgery in Modern Warfare. American Journal of Orthopedic Surgery, **16,** 415.
STEINDLER, A. (1915): The Method of Direct Neurotization of Paralyzed Muscles. American Journal of Orthopedic Surgery.
STERN, W. G. (1910): Problems in the Treatment of Club-foot. American Journal of Orthopedic Surgery, **8,** 131.
STERN, W. G. (1913): Spontaneous Gangrene and Allied Conditions in Orthopedic Surgery. American Journal of Orthopedic Surgery, **10,** 381.
STOFFEL, A. (1913): The Treatment of Spastic Contractures. American Journal of Orthopedic Surgery, **10,** 611.
SWAIM, L. T. (1915): The Mechanically Unfit. A Study of Type Forms in Chronic Invalids. American Journal of Orthopedic Surgery, **13,** 280.
TAYLOR, H. L. (1908): Present-day Needs of an Orthopedic Service. American Journal of Orthopedic Surgery, **6,** 1.
TAYLOR, H. L., and FRIEDER, W. (1915): Quiet Hip Disease. American Journal of Orthopedic Surgery, **13,** 192.
TAYLOR, R. T. (1903): Hip Disease, Considered with Special Reference to Diagnosis and the Combined Treatment. American Journal of Orthopedic Surgery, **1,** 143.
TAYLOR, R. T. (1916): Shortening Long Legs and Lengthening Short Legs: A New Surgical Procedure. American Journal of Orthopedic Surgery, **14,** 598.
TAYLOR, R. T., and KNORR, E. A. (1907): A Study of Vaccines and the Opsonic Index in Relation to Orthopedic Surgery. American Journal of Orthopedic Surgery, **5,** 32.
THOMAS, H. B. (1914): Artificial Ankylosis of Spinal Vertebrae. American Journal of Orthopedic Surgery. **12,** 265.

WALLACE, C. (1907): The Effect of Imperfect Hygiene in the Production of Bone Tuberculosis. American Journal of Orthopedic Surgery, **5,** 335.
WHITMAN, R. (1901): The Operative Treatment of Paralytic Talipes of the Calcaneus Type. American Journal of the Medical Sciences, **122,** 593.
WHITMAN, R. (1902): A New Method of Treatment for Fracture of the Neck of the Femur. Transactions of the American Orthopedic Association, **15,** 338.
WILSON, H. A., and MUSCHLITZ, C. H. (1909): The Painful Feet of Raynaud's Disease. American Journal of Orthopedic Surgery, **6,** 664.

Part IV

PATHOLOGY

ALBRIGHT, F., BAUER, W., ROPES, M., and AUB, J. C. (1929): Studies of calcium and phosphorus metabolism; effect of parathyroid hormone. Journal of Clinical Investigation, **7,** 139.
ALBRIGHT, F., BUTLER, A. M., HAMPTON, A. O., and SMITH, P. (1937): Syndrome characterized by osteitis fibrosa disseminata, areas of pigmentation, and endocrine dysfunction. with precocious puberty in females. New England Journal of Medicine, **216,** 727.
ALBRIGHT, F., BURNETT, C. H., PARSON, W., REIFENSTEIN, E. C., and ROOS, A. (1946): Osteomalacia and late rickets. Medicine, **25,** 399.
BAKWIN, H., BODANSKY, O., and SCHORR, R. (1940): Refractory rickets. American Journal of Diseases of Children, **59,** 560.
BARR, D. P., BULGER, H. A., and DIXON, H. H. (1929): Hyperparathyroidism. Journal of the American Medical Association, **92,** 951.
BODANSKY, A., and JAFFE, H. L. (1934): Phosphatase studies; serum phosphatase in diseases of bone; interpretation and significance. Archives of Internal Medicine, **54,** 88.
BODANSKY, A., and JAFFE, H. L. (1934): Phosphatase studies: serum phosphatase as a criterion of the severity and rate of healing of rickets. American Journal of Diseases of Children, **48,** 1268.
CAFFEY, J., and SILVERMAN, W. A. (1945): Infantile cortical hyperostoses: Preliminary report on a new syndrome. American Journal of Roentgenology and Radium Therapy, **54,** 1.
CAHAN, W. G., WOODARD, H. Q., HIGINBOTHAM, N. L., STEWART, F. W., and COLEY, B. L. (1948): Sarcoma arising in irradiated bone: Report of eleven cases. Cancer, **1,** 3.
CASTLEMAN, B., and MALLORY, T. B. (1935): The pathology of the parathyroid gland in hyperparathyroidism; study of twenty-five cases. American Journal of Pathology, **11,** 1.
CASTLEMAN, B., and MALLORY, T. B. (1937): Parathyroid hyperplasia in chronic renal insufficiency. American Journal of Pathology, **13,** 553.
COLLIP, J. B. (1925): The extraction of a parathyroid hormone which will prevent or control parathyroid tetany and which regulates the level of blood calcium. Journal of Biological Chemistry, **63,** 395.
COLLIP, J. B. (1926): The parathyroid glands. Medicine, **5,** 1.
FALCONER, M. A., Cope, C. L., and ROBB-SMITH, A. (1942): Fibrous dysplasia of bone, with endocrine disorders and cutaneous pigmentation (Albright's disease). Quarterly Journal of Medicine, **N.S. 11,** 121.
GINZLER, A. M., and JAFFE, H. L. (1939): Osseous findings in chronic renal insufficiency in adults. Archives of Pathology, **27,** 798.
GREEN, W. T., and FARBER, S. (1942): " Eosinophilic or solitary granuloma " of bone. Journal of Bone and Joint Surgery, **24,** 499.
HATCHER, C. H. (1945): The development of sarcoma in bone subjected to roentgen or radium irradiation. Journal of Bone and Joint Surgery, **27,** 179.
JAFFE, H. L. (1933): Hyperparathyroidism. Archives of Pathology, **16,** 63; 236. (This article summarizes and contains the references on experimental work as published in a number of papers between 1930 and 1933.)
JAFFE, H. L. (1933): Paget's disease of bone. Archives of Pathology, **15,** 83. (This article is a critical discussion of the pathology of the disease, and includes among other questions a consideration of the supposed occurrence of Paget's disease in animals.)
JAFFE, H. L. (1935): Osteoid-osteoma: A benign osteoblastic tumor composed of osteoid and atypical bone. Archives of Surgery, **31,** 709.
JAFFE, H. L. (1945): Fibrous dysplasia of bone; a disease entity and specifically not an expression of neurofibromatosis. Journal of Mount Sinai Hospital, **12,** 364.
JAFFE, H. L., LICHTENSTEIN, L., and PORTIS, R. (1940): Giant-cell tumor of bone: its pathologic appearance, grading, supposed variants and treatment. Archives of Pathology, **30,** 993.
JAFFE, H. L., and LICHTENSTEIN, L. (1940): Osteoid-osteoma: Further experience with this benign tumor of bone, with special reference to cases showing the lesion in relation to shaft cortices and commonly misclassified as instances of sclerosing non-suppurative osteomyelitis or cortical-bone abscess. Journal of Bone and Joint Surgery, **22,** 645.
JAFFE, H. L., and BODANSKY, A. (1943): Serum calcium: Clinical and biochemical considerations. Journal of Mount Sinai Hospital, **9,** 901.

JAFFE, H. L., and LICHTENSTEIN, L. (1944): Eosinophilic granuloma of bone: A condition affecting one, several or many bones, but apparently limited to the skeleton, and representing the mildest clinical expression of the peculiar inflammatory histiocytosis also underlying Letterer-Siwe disease and Schüller-Christian disease. Archives of Pathology, **37,** 99.

KAHLSTROM, S. C., BURTON, C. C., and PHEMISTER, D. B. (1939): Bone and joint changes in caisson disease, including infarction and deforming arthritis. Surgery, Gynecology and Obstetrics, **68,** 129.

LICHTENSTEIN, L. (1938): Polyostotic fibrous dysplasia. Archives of Surgery, **36,** 874.

LICHTENSTEIN, L., and JAFFE, H. L. (1940): Eosinophilic granuloma of Bone. American Journal of Pathology, **16,** 595.

LICHTENSTEIN, L., and JAFFE, H. L. (1942): Fibrous dysplasia of bone; a condition affecting one, several or many bones, the graver cases of which may present abnormal pigmentation of skin, premature sexual development, hyperthyroidism or still other extra-skeletal abnormalities. Archives of Pathology, **33,** 777.

LICHTENSTEIN, L., and JAFFE, H. L. (1947): Ewing's sarcoma of bone. American Journal of Pathology, **23,** 43.

MANDL, F. (1926): Klinisches und Experimentelles zur Frage der lokalisierten und generalisierten Ostitis fibrosa. Archiv für klinische Chirurgie, **143,** 1; 245.

OTANI, S., and EHRLICH, J. C. (1940): Solitary granuloma of bone simulating primary neoplasm. American Journal of Pathology, **16,** 479.

PHEMISTER, D. B. (1926): Radium necrosis of bone. American Journal of Roentgenology, **16,** 340.

PHEMISTER, D. B. (1930): Chondrosarcoma of bone. Surgery, Gynecology and Obstetrics, **50,** 216.

PHEMISTER, D. B. (1930): Repair of bone in the presence of aseptic necrosis resulting from fractures, transplantations and vascular obstruction. Journal of Bone and Joint Surgery, **12,** 769.

PONSETI, I., and BARTA, C. K. (1947): Osteoid osteoma. Journal of Bone and Joint Surgery, **29,** 767.

SHERMAN, M. S. (1947): Osteoid osteoma; Review of the literature and report of thirty cases. Journal of Bone and Joint Surgery, **29,** 918.

STOUT, A. P. (1943): A discussion of the pathology and histogenesis of Ewing's tumor of bone marrow. American Journal of Roentgenology and Radium Therapy, **50,** 334.

ARTHROPLASTY

ALLISON, N., and BROOKS, B. (1915): Ankylosis: an Experimental Study. Journal of the American Medical Association, **64,** 391.

BAER, W. S. (1909): A Preliminary Report of the Use of Animal Membrane in Producing Mobility in Ankylosed Joints. American Journal of Orthopedic Surgery, **7,** 1.

BAER, W. S. (1918): Arthroplasty with the Aid of Animal Membrane. American Journal of Orthopedic Surgery, **16,** 1; **16,** 94; **16,** 171.

BARTON, J. R. (1827): On the Treatment of Ankylosis by the Formation of Artificial Joints. North American Medical and Surgical Journal, **3,** 279; **3,** 400.

CAMPBELL, W. C. (1931): The Physiology of Arthroplasty. Journal of Bone and Joint Surgery, **13,** 223. Sir Robert Jones Lecture delivered at the Hospital for Joint Diseases, October 18, 1930.

HENDERSON, M. S. (1918): What are the Real Results of Arthroplasty? American Journal of Orthopedic Surgery, **16,** 30.

JUDET, JEAN and ROBERT (1950): The Use of an Artificial Femoral Head for Arthroplasty of the Hip Joint. Journal of Bone and Joint Surgery, **32-B,** 166.

MACAUSLAND, W. R. (1923): Mobilization of Ankylosed Joints. Surgery, Gynecology and Obstetrics, **37,** 255.

MURPHY, J. B. (1905): Ankylosis, Arthroplasty, Clinical and Experimental. Journal of the American Medical Association, **44,** 1573; **44,** 1671; **44,** 1749.

MURPHY, J. B. (1913): Arthroplasty. Annals of Surgery, **57,** 593.

SMITH-PETERSEN, M. N. (1939): Arthroplasty of the Hip; A New Method. Journal of Bone and Joint Surgery, **21,** 269.

SMITH-PETERSEN, M. N. (1948): Evolution of Mould Arthroplasty of the Hip Joint. Journal of Bone and Joint Surgery, **30-B,** 59.

ARTHRODESIS

ABBOTT, L. C., SCHOTTSTAEDT, E. R., SAUNDERS, J. B., and BOST, F. C. (1947): The Evaluation of Cortical and Cancellous Bone as Grafting Material. Journal of Bone and Joint Surgery, **29,** 381.

ALBEE, F. H. (1911): Transplantation of Portion of Tibia into the Spine for Pott's Disease. Journal of the American Medical Association, **57,** 885.

ALBERT, E. (1881): Zentralblatt für Chirurgie, **48,** 1881.

BARR, J. S. (1937): Sciatica Caused by Intervertebral-disc Lesions. Journal of Bone and Joint Surgery, **19,** 323.

BARR, JOSEPH S., FREIBERG, JOSEPH A., COLONNA, PAUL C., and PEMBERTON, PAUL A. (1942): A survey of end-results on stabilization of the paralytic shoulder. Report of the Research Committee of the American Orthopaedic Association. Journal of Bone and Joint Surgery, **24,** 699.

BOSWORTH, D. M. (1946): Knee Fusion by the use of a Three-flanged Nail. Journal of Bone and Joint Surgery, **28,** 550.
CAMPBELL, W. C. (1923): An Operation for the Correction of "Drop-foot." Journal of Bone and Joint Surgery, **5,** 815.
CLEVELAND, M. (1935): Fusion of a Knee Joint in Charcot's Disease. Journal of Bone and Joint Surgery, **17,** 1031.
COBB, J. R. (1943): Treatment of Scoliosis. Connecticut State Medical Journal, **7,** 467.
DAVIS, G. (1913): The Treatment of Hollow Foot (Pes Cavus). American Journal of Orthopedic Surgery, **11,** 231.
GALLIE, W. E. (1943): Substragalar Arthrodesis in Fractures of the Os Calcis. Journal of Bone and Joint Surgery, **25,** 731.
HIBBS, R. A. (1911): An Operation for Progressive Spinal Deformities. New York Medical Journal, **93,** 1013.
HIBBS, R. A. (1911): An Operation for Stiffening of the Knee Joint. Annals of Surgery, **53,** 404.
HIBBS, R. A. (1926): Twenty Cases of Hip Joint Tuberculosis Treated by an Operation Devised to Eliminate Motion by Fusing the Joint. Journal of Bone and Joint Surgery, **8,** 522.
HOKE, M. (1921): An Operation for Stabilizing Paralytic Feet. Journal of Orthopaedic Surgery, **3,** 494.
MILGRAM, J. E. (1931): Rotation Arthrodesis of Knee. Surgery, Gynecology and Obstetrics, **53,** 355.
RYERSON, E. W. (1923): Arthrodesing Operations on the Feet. Journal of Bone and Joint Surgery, **5,** 453.
WATSON-JONES, R. (1934): Inadequate Immobilization and Non-union of Fractures. British Medical Journal, **1,** 936.
WATSON-JONES, R. (1938): Arthrodesis of the Osteoarthritic Hip. Journal of the American Medical Association, **110,** 278.
WHITMAN, R. (1901): The Operative Treatment of Paralytic Talipes of the Calcaneus Type. American Journal of the Medical Sciences, **122,** 593.

OSTEOTOMY

BARTON, JOHN RHEA (1827): On the treatment of anchyloses by the formation of artificial joints. North American Medical and Surgical Journal, **III,** 279; **IV,** 310.
BATCHELOR, J. S. (1945): Excision of femoral head and neck in ankylosis and osteoarthritis of hips. Proceedings of the Royal Society of Medicine (Section of Orthopaedics), **38,** 689.
BLOUNT, W. P. (1943): Blade-Plate internal fixation for high femoral osteotomies. Journal of Bone and Joint Surgery, **25,** 319.
BOSWORTH, D. M. (1942): Femoro-Ischial Transplantation. Journal of Bone and Joint Surgery, **24,** 38.
BRITTAIN, H. A. (1942): Architectural Principles in Arthrodesis. Baltimore: Williams & Wilkins.
DICKSON, J. A. (1947): High Geometric Osteotomy. Journal of Bone and Joint Surgery, **29,** 1005.
GAENSLEN, F. J. (1935): The Schanz subtrochanteric Osteotomy. Journal of Bone and Joint Surgery, **17,** 76.
GALLAND, W. I. (1930): The Bifurcation Operation. Surgery, Gynecology and Obstetrics, **50,** 90.
HIBBS, R. A. (1915): Anteversion of the Neck of the Femur. Journal of the American Medical Association, **65,** 1801.
KIRMISSON, ED. (1894): De l'ostéotomie sous-Trochantérienne. Revue d'Orthopédie, 1e série, **5,** 137.
LORENZ, A. (1919): Bifurkation des oberen Femurendes. Wiener klinische Wochenschrift, **32,** 997.
MCMURRAY, T. P. (1935): Osteo-Arthritis of the Hip Joint. British Journal of Surgery, **22,** 716.
MILCH, H. (1943): Resection of Femoral Neck with Pelvic Support Osteotomy for Ankylosis of the Hip. Surgery, **13,** 55.
MILCH, H. (1944): Postosteotomy Angle. Journal of Bone and Joint Surgery, **26,** 394.
MILCH, H. (1947): Osteotomy of the Long Bones. Springfield, Illinois: Charles C. Thomas.
PAUWELS, F. (1935): Der Schenkelhalsbruch. Stuttgart: Ferdinand Enke.
PUTTI, V. (1937): L'ostéotomie Intertrochantérienne. Presse Médicale, **45,** 1841.
REITH, R. S. (1925): The Bifurcation Operation for the Treatment of irreducible dislocations of the hip joint. Journal of Bone and Joint Surgery, **7,** 598.
SCHANZ, A. (1922): Zur Behandlung der veralteten angeborenen Hüftverenkung. Münchener medizinische Wochenschrift, **69,** 930.
TRUMBLE, H. C. (1932): Fixation of Hip by Extra-articular Bone graft. Australian and New Zealand Journal of Surgery, **1,** 413.
VON BAEYER (1918): Operative Behandlung von nicht reponierbaren angeborenen Hüftverenkungen. Münchener medizinische Wochenschrift, **65,** 1218.

BONE GRAFTING

ABBOTT, L. C., SCHOTTSTAEDT, E. R., SAUNDERS, J. B. DE C. M., and BOST, F. C. (1947): Evaluation of Cortical and Cancellous Bone as Grafting Material; Clinical and Experimental Study. Journal of Bone and Joint Surgery, **29,** 381.
ALBEE, F. H. (1911): Transplantation of Portion of Tibia into the Spine for Pott's Disease. Journal of the American Medical Association, **57,** 885.

ALBEE, F. H. (1919): Orthopaedic and Reconstructive Surgery. Philadelphia: W. B. Saunders Co.
ALBEE, F. H. (1930): Principles of Treatment of Non-union of Fracture. Surgery, Gynceology and Obstetrics, **51,** 289.
BOYD, H. B. (1941): Congenital Pseudarthrosis. Treatment by Dual Bone Grafts. Journal of Bone and Joint Surgery, **23,** 497.
BOYD, H. B. (1943): The Treatment of Difficult and Unusual Non-unions, with Special Reference to Bridging of Defects. Journal of Bone and Joint Surgery, **25,** 535,
CAMPBELL, W. C. (1927): The Onlay Graft in the Treatment of Ununited Fractures of Long Bones. Southern Medical Journal, **20,** 107.
FLANAGAN, J. J., and BUREM, H. S. (1947): Reconstruction of Defects of Tibia and Femur with Apposing Massive Grafts from Affected Bone. Journal of Bone and Joint Surgery, **29,** 587.
HENDERSON, M. S. (1928) Massive Bone Graft applied for non-union of the Humerus. Surgery, Gynecology and Obstetrics, **46,** 397.
HIBBS, R. A. (1911): An Operation for Progressive Spinal Deformities. New York Medical Journal, **93,** 1013.
INCLAN, A. (1942): The Use of Preserved Bone Graft in Orthopaedic Surgery. Journal of Bone and Joint Surgery, **24,** 81.
MACEWEN, W. (1912): The Growth of Bone. Observations on Osteogenesis. Glasgow: J. Maclehose & Sons.
OLLIER, L. (1867): Traité Expérimental et Clinique de la Régénération des os et de la Production Artificielle du Tissu Osseux. Paris: Masson et fils.
PHEMISTER, D. B. (1931): Splint Grafts in the Treatment of Delayed and Non-union of Fractures. Surgery, Gynecology and Obstetrics, **52,** 376.
VENABLE, C. S., STUCK, W. B., and BEACH, A. (1937): The Effects on Bone of the Presence of Metals; based upon Electrolysis. Annals of Surgery, **105,** 917.

POLIOMYELITIS

BARTOW, B., and PLUMMER, W. W. (1911, 1912, 1916): The Use of Intra-articular Silk Ligaments for Fixation of Loose Joints in the Residual Paralysis of Anterior Poliomyelitis. American Journal of Orthopedic Surgery, **9,** 65; **10,** 499; **14,** 594.
BIESALSKI, K., and MAYER, L. (1916): Die physiologische Sehnenverpflanzung. Berlin: J. Springer.
BUNNELL, S. (1918, 1922): Repair of Tendons in the Fingers. Surgery, Gynecology and Obstetrics, **26,** 103; **35,** 88.
BUNNELL, S. (1932): Contractures of the Hand from Infections and Injuries. Journal of Bone and Joint Surgery, **14,** 27.
BUNNELL, S. (1938): Opposition of the Thumb. Journal of Bone and Joint Surgery, **20,** 269.
BUNNELL, S. (1942): Surgery of the Intrinsic Muscles of the Hand other than those producing opposition of the Thumb. Journal of Bone and Joint Surgery, **24,** 1.
CAMBPELL, W. C. (1925): Transference of the Crest of the Ilium for Flexion Contracture of the Hip. Southern Medical Journal, **16,** 289.
CAMPBELL, W. C. (1936): Repair of the Ligaments of the Knee. Surgery, Gynecology and Obstetrics, **62,** 964.
DAVIS, G. G. (1913): Treatment of Hollow Foot (Pes Cavus). American Journal of Orthopedic Surgery, **11,** 231.
DUNN, N. (1922): Stabilizing Operations in Paralytic Feet. Proceedings of the Royal Society of Medicine (Section of Orthopaedics), **15,** 15.
GALLIE, W. E., and LE MESURIER, A. B. (1922): A Clinical and Experimental Study of the Free Transplantation of Fascia and Tendon. Journal of Bone and Joint Surgery, **41,** 600.
GILL, A. B. (1931): Operation for Correction of Paralytic Genu Recurvatum. Journal of Bone and Joint Surgery, **13,** 49.
HIBBS, R. A., RISSER, J. C., and FERGUSON, A. B. (1931): Scoliosis Treated by the Fusion Operation. Journal of Bone and Joint Surgery, **13,** 91.
HOKE, M. (1921): An Operation for Stabilizing Paralytic Feet. Journal of Orthopaedic Surgery, **3,** 494.
HOKE, M. (1931): An Operation for the Correction of Extremely Relaxed Flat Feet. Journal of Bone and Joint Surgery, **13,** 773.
LAMBRINUDI, C. (1932): A Method of Correcting Equinus and Calcaneous Deformities at the Sub-Astragaloid Joint. Proceedings of the Royal Society of Medicine (Section of Orthopaedics), **26,** 788.
L'EPISCOPO, J. B. (1939): Restoration of Muscle Balance in the Treatment of Obstetrical Paralysis. New York Journal of Medicine, **39,** 357.
LOVETT, R. W. (1916): The Spring Balance Muscle Test. American Journal of Orthopedic Surgery, **14,** 415.
MCCARROLL, H. R. (1944): Evaluation of the Kenny Treatment of Infantile Paralysis: Report of Committee. Journal of the American Medical Association, **125,** 446.
MAYER, L. (1916): The Physiological Method of Tendon Transplantation. Surgery, Gynecology and Obstetrics, **22,** 182; 298; 472.

MAYER, L. (1927): Transplantation of the Trapezius for Paralysis of the Abductors of the Arm. Journal of Bone and Joint Surgery, **9,** 412.
MAYER, L. (1930): An Operation for the Cure of Paralytic Genu Recurvatum. Journal of Bone and Joint Surgery, **12,** 845.
MAYER, L. (1944): Significance of the Iliocostal Fascial Graft in the Treatment of Paralytic Deformities of the Trunk. Journal of Bone and Joint Surgery, **26,** 257.
MILGRAM, J. E. (1931): Rotation Arthrodesis of Knee. Surgery, Gynecology and Obstetrics, **53,** 355.
OBER, F. R. (1927): An Operation for the Relief of Paralysis of the Gluteus Maximus Muscle. Journal of the American Medical Association, **88,** 1063.
PEABODY, C. W. (1938): Tendon Transposition. An End-result Study. Journal of Bone and Joint Surgery, **20,** 193.
POHL, JOHN F. (1943): The Kenny Concept of Infantile Paralysis and its Treatment. St Paul, Minnesota: Bruce Publishing Co.
POHL, JOHN F. (1947): The Peripheral Disease of Poliomyelitis. Journal of Bone and Joint Surgery, **29,** 1027.
RYERSON, E. W. (1916): Methods of Stabilizing the Flail Foot in Infantile Paralysis. American Journal of Orthopedic Surgery, **14,** 387.
RYERSON, E. W. (1923): Arthrodesing Operations on the Feet. Journal of Bone and Joint Surgery, **5,** 453.
SOUTTER, R. (1914): A New Operation for Hip Contractures in Poliomyelitis. Boston Medical and Surgical Journal, **170,** 380.
STEINDLER, A. (1919): Operative Treatment of Paralytic Conditions of the Upper Extremity. Journal of Orthopaedic Surgery, **1,** 608.
THOMPSON, T. C. (1945): Quadricepsplasty. Annals of Surgery, **121,** 751.
WHITMAN, R. (1901): The Operative Treatment of Paralytic Talipes of the Calcaneus Type. American Journal of the Medical Sciences, **122,** 593.

RECURRENT DISLOCATION OF THE SHOULDER

ADAMS, J. C. (1948): Recurrent Dislocation of the Shoulder. Journal of Bone and Joint Surgery, **30–B,** 26.
HELLENS, ARNO VON (1947): Über die Habituelle Schulterluxation. Annals Chirurgiae et Gynaecologiae Fenniae, **36,** 1.
BANKART, A. S. BLUNDELL (1923): Recurrent or Habitual Dislocation of the Shoulder Joint. British Medical Journal, **ii,** 1132.
BANKART, A. S. BLUNDELL (1938): Pathology and Treatment of Recurrent Dislocation of the Shoulder Joint. British Journal of Surgery, **26,** 23.
BOST, F. C., and INMAN V. T. (1942): The Pathological Changes in Recurrent Dislocation of the Shoulder. Journal of Bone and Joint Surgery, **24,** 595.
BROCA, A., and HARTMANN, H. (1890): Bulletins de la Société Anatomique de Paris, 5me série, **4,** 312.
DE PALMA, A. F., CALLERY, GERALD, and BENNETT, GEORGE A., (1949): Variational Anatomy and Degenerative Lesions of the Shoulder Joint. Instructional Course Lecture, American Academy of Orthopaedic Surgeons, **6,** 255.
FAHEY, J. J., and DE COSOLA, MICHAEL (1947): Pathology of the Shoulder after Experimental Dislocation at Autopsy. Scientific Exhibit Meeting of the American Academy of Orthopaedic Surgeons, Chicago.
FLOWER, W. H. (1861): On the Pathological Changes Produced in the Shoulder Joint by Traumatic Dislocation. Transactions of the Pathological Society, London, **12,** 179.
GALLIE, W. E., and LE MESURIER, A. B. (1948): Recurring Dislocation of the Shoulder. Journal of Bone and Joint Surgery, **30–B,** 9.
GRANT, J. C. B. (Gallie and Le Mesurier).
HILL, H. A., and SACHS, M. D. (1940): The Grooved Defect of the Humeral Head, a Frequently Unrecognized Complication of Dislocations of the Shoulder Joint. Radiology, **35,** 690.
MAGNUSON, P. B., and STACK, J. K. (1943): Recurrent Dislocation of the Shoulder. Journal of the American Medical Association, **123,** 889.
NICOLA, TOUFICK (1934): Recurrent Dislocation of the Shoulder. Journal of Bone and Joint Surgery, **16,** 663.
OSMOND-CLARKE, H. (1948): Habitual Dislocation of the Shoulder. Journal of Bone and Joint Surgery, **30–B,** 19.
PALMER, IVAR, and WIDÉN, ANDERS (1948): The Bone Block Method for Recurrent Dislocation of the Shoulder Joint. Journal of Bone and Joint Surgery, **30–B,** 53.

CONGENITAL DISLOCATION OF THE HIP

BOST, F. C., HAGEY, H., SCHOTTSTAEDT, E. R., and LARSEN, L. J. (1948): The Results of Treatment of Congenital Dislocation of the Hip in Infancy. Journal of Bone and Joint Surgery, **30–A,** 454.
BRADFORD, E. H. (1894, 1900, 1902): Congenital Dislocation of the Hip Joint. Transactions of the American Orthopedic Association, **7,** 88; **13,** 124; **15,** 284.

COLE, W. H. (1935): The Open Treatment of Congenital Dislocation of the Hip; the Operative Technique with some of its Complications. Journal of Bone and Joint Surgery, **17,** 18.

COMPERE, E. L., and PHEMISTER, D. B. (1935): The Tibial Peg Shelf in Congenital Dislocation of the Hip. Journal of Bone and Joint Surgery, **17,** 60.

CREGO, Jr., C. H., and SCHWARTZMANN, J. R. (1948): Follow-up Study of the Early Treatment of Congenital Dislocation of the Hip. Journal of Bone and Joint Surgery, **30-A,** 428.

DAVIS, G. G. (1907): A method of reduction of Congenital Luxation of the Hip by Manipulation. American Journal of Orthopedic Surgery, **4,** 276.

DAVIS, G. G. (1908): A Case of Double Dislocation of the Hip Replaced by Manipulation. Archives of Pediatrics, **25,** 867.

DICKSON, F. D. (1935): The Shelf Operation in Treatment of Congenital Dislocation of the Hip. Journal of Bone and Joint Surgery, **17,** 43.

FARRELL, B. P., and HOWARTH, M. B. (1935): Open Reduction in Congenital Dislocation of the Hip. Journal of Bone and Joint Surgery, **17,** 35.

FARRELL, B. P., VON LACKUM, H. L., and SMITH, A. DE F. (1926): Congenital Dislocation of the Hip; Report of 310 Cases Treated at New York Orthopaedic Dispensary and Hospital. Journal of Bone and Joint Surgery, **8,** 551.

FREIBERG, A. H. (1935): Congenital Luxation of Hip; Selection of Cases for Open Reduction. Journal of Bone and Joint Surgery, **17,** 1.

GALLOWAY, H. P. H. (1920): The Open Operation for Congenital Dislocation of the Hip. Journal of Orthopaedic Surgery, **2,** 390.

GALLOWAY, H. P. H. (1926): The Open Operation for Congenital Dislocation of the Hip; Special Reference to Results. Journal of Bone and Joint Surgery, **8,** 539.

GILL, A. B. (1935): Plastic Construction of an Acetabulum in Congenital Dislocation of the Hip—the Shelf Operation. Journal of Bone and Joint Surgery, **17,** 48.

GILL, A. B. (1936): An Evaluation of Present-day Methods of Dealing with Congenital Dislocation of the Hip. Journal of Bone and Joint Surgery, **18,** 487.

GILL, A. B. (1948): The End-results of the Early Treatment of Congenital Dislocation of Hip, with an Inquiry into the Factors that Determine the Result. Journal of Bone and Joint Surgery, **30-A,** 442.

KIDNER, F. C. (1935): Comparative Analysis of the Results of Open and Closed Reductions in Congenital Dislocation of the Hip. Journal of Bone and Joint Surgery, **17,** 25.

KLEINBERG, S., and LIEBERMAN, H. S. (1936): The Acetabular Index in Infants in Relation to Congenital Dislocation of the Hip. Archives of Surgery, **32,** 1049.

LORENZ, A. (1896): Cure of Congenital Luxation of the Hip by Bloodless Reduction and Weighting. Transactions of the American Orthopedic Association, **9,** 254.

MCCARROLL, H. R. (1948): Primary Anterior Congenital Dislocation of the Hip. Journal of Bone and Joint Surgery, **30-A,** 416.

OBER, F. R. (1935): Shelf Operation to Relieve Persistent Dislocation of Hip; A Report on Results. Journal of Bone and Joint Surgery, **17,** 73.

PACI, A. (1888): Studio ed osservazione sulla lussazione iliaca commune congenita e sua cura razionale. Genova.

PONSETI, I. (1946): Pathomechanics of the Hip after the Shelf Operation. Journal of Bone and Joint Surgery, **28,** 229.

STEWART, S. F. (1935): The Physiological Treatment of Congenital Dislocation of the Hip. Journal of Bone and Joint Surgery, **17,** 11.

CONTROL OF BONE LENGTH

ABBOTT, L. C. (1927): The operative lengthening of the tibia and fibula. Journal of Bone and Joint Surgery, **9,** 128.

ABBOTT, L. C., and CREGO, C. H. (1928): Operative lengthening of the femur. Southern Medical Journal, **21,** 823.

ABBOTT, L. C., and SAUNDERS, J. B. (1936): The operative lengthening of the tibia and fibula. Annals of Surgery, **110,** 961.

BARR, J. S., LINGLEY, J. R., and GALL, E. A. (1943): the effect of roentgen irradiation on epiphysial growth. American Journal of Roentgenology and Radium Therapy, **49,** 104.

BISGARD, J. D., and BISGARD, M. E. (1935): Longitudinal growth of long bones. Archives of Surgery, **31,** 568.

BLOUNT, W. P., and CLARKE, G. R. (1949): Control of bone growth by epiphysial stapling. Journal of Bone and Joint Surgery, **31-A,** 464.

BROCKWAY, A. (1935): Clinical résumé of forty-six leg-lengthening operations. Journal of Bone and Joint Surgery, **17,** 969.

BROOKE, J. A. (1927): Shortening of bones of the leg to correct inequality of length. Surgery, Gynecology and Obstetrics, **44,** 703.

CALVÉ, J., and GALLAND, M. (1918): A new procedure for compensatory shortening of the unaffected femur. American Journal of Orthopedic Surgery, **16,** 211.
CODIVILLA, A. (1905): On the means of lengthening, in the lower limbs, the muscles and tissues which are shortened through deformity. American Journal of Orthopedic Surgery, **2,** 353.
GREEN, WM. T., and ANDERSON, MARGARET (1947): Experiences with epiphysial arrest in correcting discrepancies in length of the lower extremities in infantile paralysis. Journal of Bone and Joint Surgery, **29,** 659.
HAAS, S. L. (1945): Retardation of bone growth by a wire loop. Journal of Bone and Joint Surgery, **27,** 25.
HAAS, S. L. (1948): Mechanical Retardation of bone growth. Journal of Bone and Joint Surgery, **30–A,** 506.
HABOUSH, E. J., and FINKELSTEIN, H. (1932): Leg lengthening with stabilizing apparatus. Journal of Bone and Joint Surgery, **14,** 807.
HARRIS, R. I. (1930): The effect of lumbar sympathectomy on the growth of legs shortened from anterior poliomyelitis. A preliminary report. Journal of Bone and Joint Surgery, **12,** 859.
MAGNUSON, P. B. (1908): Lengthening shortened bones of the leg by operation. Pennsylvania University Medical Bulletin, **21,** 103.
MAGNUSON, P. B. (1913): Surgery, Gynecology and Obstetrics, **17,** 63.
PHEMISTER, D. B. (1933): Operative arrestment of longitudinal growth of bones in the treatment of deformities. Journal of Bone and Joint Surgery, **15,** 1.
PUTTI, V. (1921): The operative lengthening of the femur. Journal of the American Medical Association, **77,** 934.
SHANDS, A. R. (1917): Shortening of the long leg. International Journal of Surgery, **30,** 273.
STINCHFIELD, ALLAN J., REIDY, JOHN, and BARR, JOS. (1949): Prediction of unequal growth of the lower extremities in anterior poliomyelitis. Journal of Bone and Joint Surgery, **31–A,** 478.
STRAUB, L. R., THOMPSON, T. C., and WILSON, P. D. (1945): The results of epiphyseodesis and femoral shortening in relation to equalization of limb length. Journal of Bone and Joint Surgery, **27,** 254.
TAYLOR, R. T. (1916): Shortening long legs and lengthening short legs. American Journal of Orthopedic Surgery, **14,** 598.
WHITE, J. W. (1935): Femoral shortening for equalization of leg length. Journal of Bone and Joint Surgery, **17,** 597.
WHITE, J. W., and STUBBINS, S. G. (1944): Growth arrest for equalizing leg lengths. Journal of the American Medical Association, **126,** 1146.
WILSON, P. D., and THOMPSON, T. C. (1939): A clinical consideration of the methods of equalizing leg length. Annals of Surgery, **110,** 992.
WU, Y. K., and MILTNER, L. J. (1937): A procedure for stimulation of longitudinal growth of bone. Journal of Bone and Joint Surgery, **19,** 909.

BACK PAIN AND SCIATICA

ALBEE, R. H. (1911): Transplantation of portion of the tibia into the spine for Pott's disease. Journal of the American Medical Association, **57,** 885.
BARR, J. S. (1937): "Sciatica" caused by Intervertebral-disc lesions. A report of forty cases of rupture of the intervertebral disc occurring in the low lumbar spine and causing pressure on the cauda equina. Journal of Bone and Joint Surgery, **19,** 323.
BEADLE, O. A. (1931): The Intervertebral Discs. Observations on their normal and morbid anatomy in relation to certain spinal deformities. Medical Research Council, Special Report series No. 161, London.
BUCY, P. C. (1930): Chondroma of intervertebral disk. Journal of the American Medical Association, **94,** 1552.
DANDY, W. E. (1929): Loose cartilage from intervertebral disk simulating tumor of the spinal cord. Archives of Surgery, **19,** 660.
FRIBERG, S. (1941): Low back and sciatic pain caused by intervertebral disc herniation. Acta Chirurgica Scandinavica, Supplement 64.
GOLDTHWAIT, J. E. (1907): The Pelvic Articulations. Journal of the American Medical Association, **49,** 768.
GOLDTHWAIT, J. E. (1911): The lumbo-sacral articulation; an explanation of many cases of "lumbago," "sciatica," and paraplegia. Boston Medical and Surgical Journal, **164,** 365.
HIBBS, R. A. (1911): An operation for progressive spinal deformities. New York Medical Journal, **93,** 1013.
HIBBS, R. A., and SWIFT, W. E. (1929): Developmental abnormalities at the lumbo-sacral juncture causing pain and disability; report of 147 patients treated by the spine fusion operation. Surgery, Gynecology and Obstetrics, **48,** 604.
HIRSCH, C. (1948): Instability in Degeneration of lumbar disk; anatomic study. Nordisk Medicin, **38,** 1252.
KEYES, D. C., and COMPERE, E. L. (1932): The Normal and Pathological Physiology of the Nucleus Pulposus of the Intervertebral Disc. Journal of Bone and Joint Surgery, **14,** 897.
KOCHER, THEODOR (1896): Die Verletzungen der Wirbelsäule zugleich als Beitrag zur Physiologie des menschlichen Rückenmarks. Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie, **1,** 415.
MAURIC, G. J. J. (1933): Le disque intervertébral. Paris: Masson et Cie.

MIDDLETON, G. S., and TEACHER, J. H. (1911): Glasgow Medical Journal, **N.S. 76,** 1.
MIXTER, W. J., and BARR, J. S. (1934): Rupture of the Intervertebral disc with involvement of the spinal canal. New England Journal of Medicine, **211,** 210.
OSLER, W., and MCCRAE, T. (1920): The Principles and Practice of Medicine. Ninth edition. New York and London: D. Appleton & Company, 1057.
PETIT-DUTAILLIS, D., and ALAJOUANINE, T. (1928): Syndrome unilatéral de la queue de cheval laminectome exploratrice et ablation d'un fibrome du disque intervertébral. Bulletins et Mémoires de la Société Nationale de Chirurgie, **54,** 1452.
PUTTI, V. (1927): New Concepts in the Pathogenesis of Sciatic Pain. Lancet, **ii,** 53.
SCHMORL, GEORG (1927): Verhandlungen der Deutschen Orthopädischen Gesellschaft, **21,** 3.
SCHMORL, GEORG (1927): Verhandlungen der Deutschen Pathologischen Gesellschaft, **22,** 250.
SCHMORL, GEORG (1929): Fortschritte auf dem Gebiete der Röntgenstrahlen, **40,** 629.
SCHMORL, GEORG (1931): Archiv für Orthopädie, Mechanotherapie und Unfallchirurgie, **29,** 389.

SCOLIOSIS

ABBOTT, E. G. (1917): Scoliosis. American Journal of Orthopedic Surgery, **15,** 26; 108; 172; 243; 362.
ARKIN, ALVIN M. (1949): The mechanism of the structural changes in Scoliosis. Journal of Bone and Joint Surgery, **31-A,** 519.
COBB, J. R. (1943): Treatment of scoliosis. Connecticut State Medical Journal, **7,** 467.
FARKAS, A. (1941): Physiological Scoliosis. Journal of Bone and Joint Surgery, **23,** 607.
FARKAS, A. (1943): Paralytic Scoliosis. Journal of Bone and Joint Surgery, **25,** 581.
HIBBS, R. A. (1924): A report of fifty-nine cases of Scoliosis treated by the fusion operation. Journal of Bone and Joint Surgery, **6,** 3.
HIBBS, R. A., RISSER, J. C., and FERGUSON, A. B. (1931): Scoliosis treated by the fusion operation. Journal of Bone and Joint Surgery, **13,** 91.
HOWARTH, M. B. (1943): Evolution of spinal fusion. Annals of Surgery, **117,** 278.
KLEINBERG, S. (1922): The operative treatment of scoliosis. Archives of Surgery, **5,** 631.
KLEINBERG, S. (1926): Scoliosis. New York: P. B. Hoeber.
KLEINBERG, S. (1929): Beef-bone grafting for scoliosis. American Journal of Surgery, **6,** 803.
KLEINBERG, S. (1929): The results of spine fusion for Scoliosis. Journal of Bone and Joint Surgery, **11,** 66.
VON LACKUM, WM. H., and MILLER, J. P. (1949): Critical observations of the results in the operative treatment of Scoliosis. Journal of Bone and Joint Surgery, **31-A,** 102.
OUTLAND, TOM, and CORN, OSCAR (1947): The use of Parallel Grafts and of two-stage and three-stage interlocking grafts in the treatment of idiopathic Scoliosis. Journal of Bone and Joint Surgery, **29,** 163.
Report of Research Committee, American Orthopedic Association (1941): End-result study of the treatment of idiopathic Scoliosis. Journal of Bone and Joint Surgery, **23,** 963.
SMITH, A. DE F. (1923): A study of autopsy specimens of fused spines. Journal of Bone and Joint Surgery, **5,** 507.
SMITH, A. DE F., BUTTE, F. L., and FERGUSON, A. B. (1938): Treatment of scoliosis by the wedging jacket and spine fusion. A review of 265 cases. Journal of Bone and Joint Surgery, **20,** 825.
STEINDLER, A. (1929): Diseases and Deformities of the Spine and Thorax. St Louis: C. V. Mosby Company, 244.
WHITMAN, A. (1927): A variation in the operative treatment of structural scoliosis. Journal of the American Medical Association, **89,** 2159.

FRACTURES OF THE NECK OF THE FEMUR

BOYD, H. B., and GEORGE, I. L. (1947): Journal of Bone and Joint Surgery, **29,** 13.
COOK, A. C (1894): Transactions of the American Orthopedic Association, **7,** 348.
COTTON, F. J. (1934): Journal of Bone and Joint Surgery, **16,** 105.
COX, W. J. (1936): Journal of Bone and Joint Surgery, **18,** 134.
Fracture Committee of the American Academy of Orthopaedic Surgeons (1939): Treatment of fractures of the neck of the femur by internal fixation. Journal of Bone and Joint Surgery, **21,** 483.
Fracture Committee of the American Academy of Orthopaedic Surgeons (1941): Treatment of fractures of the neck of the femur by internal fixation. Journal of Bone and Joint Surgery, **23,** 386.
GAENSLEN, F. J. (1935): Journal of Bone and Joint Surgery, **17,** 739.
HARRIS, R. I. (1938): Experiences with internal fixation in fresh fractures of the neck of the femur. Journal of Bone and Joint Surgery, **20,** 114.
HENDERSON, M. S. (1936): Proceedings of the Staff Meetings of the Mayo Clinic, **11,** 573.
HENDERSON, M. S. (1937): Archives of Surgery, **35,** 419.
HENDERSON, M. S. (1938): Annals of Surgery, **107,** 132.
HENRY, M. O. (1931): Journal of Bone and Joint Surgery, **13,** 530.
HENRY, M. O. (1934): Journal of Bone and Joint Surgery, **16,** 168.
HENRY, M. O. (1938): Journal of Bone and Joint Surgery, **20,** 400.

JOHANSSON, S. (1932): Acta Orthopaedica Scandinavica, **3,** 362.
KING, D., LEEF, E., and TERWILLIGER, C. K. (1940): Journal of Bone and Joint Surgery, **22,** 168.
KNOWLES, F. L. (1936): Fractures of the neck of the femur. Wisconsin Medical Journal, **35,** 106.
KULOWSKI, J., and LUCK, J. V. (1941): Journal of Bone and Joint Surgery, **23,** 17.
LEADBETTER, G. W. (1933): A treatment for fracture of the neck of the femur. Journal of Bone and Joint Surgery, **15,** 931.
LEADBETTER, G. W. (1938): Closed reduction of fractures of the neck of the femur. Journal of Bone and Joint Surgery, **20,** 108.
LIPPMANN, R. K. (1939): Experiences with the corkscrew bolt. Journal of Bone and Joint Surgery, **21,** 735.
MOORE, A. T. (1934): Skeletal fixation of fracture of the hip. Journal of the South Carolina Medical Association, **30,** 199.
MOORE, A. T. (1937): Extra-articular fixation of hip with adjustable nails. Surgery, Gynecology and Obstetrics, **64,** 420.
O'MEARA, J. W. (1935): Journal of Bone and Joint Surgery, **17,** 928.
PLUMMER, W. W. (1938): Comments on internal fixation in fresh fractures of the neck of the femur. Journal of Bone and Joint Surgery, **20,** 97.
RIDLON, J. (1897): Transactions of the American Orthopedic Association, **10,** 186.
RIDLON, J., and JONES, R. (1892): Annals of Surgery, **16,** 60.
RIDLON, J., and JONES, R. (1892): Medical Recorder.
SHAFFER, N. M. (1897): Transactions of the American Orthopedic Association, **10,** 176.
SHERMAN, M. S., and PHEMISTER, D. B. (1947): Journal of Bone and Joint Surgery, **29,** 19.
SHERMAN, W. O. (1926): Operative treatment of fractures of the shaft of the femur with maximum fixation. Journal of Bone and Joint Surgery, **8,** 494.
SLOAT, J. I., and PETERSON, L. T. (1939): Journal of Bone and Joint Surgery, **21,** 1041.
SMITH-PETERSEN, M. N., CAVE, E. F., and VANGORDER, G. W. (1931): Intracapsular fractures of the neck of the femur. Archives of Surgery, **23,** 715.
SPEED, K. (1935): The Unsolved Fracture. Surgery, Gynecology and Obstetrics, **60,** 341.
TELSON, D., and RANSOHOFF, N. (1935): Fixation of the neck of the femur with steel wires. Journal of Bone and Joint Surgery, **17,** 727.
WESTCOTT, H. H. (1934): A method for the internal fixation of transcervical fractures of the femur. Journal of Bone and Joint Surgery, **16,** 372.
WHITE, J. W. (1935): An instrument facilitating use of the flanged nail in treatment of fractures of the hip. Journal of Bone and Joint Surgery, **17,** 1065.
WHITMAN, R. (1893): Medical Record, **43,** 59.
WHITMAN, R. (1897): Transactions of the American Orthopedic Association, **10,** 216.
WHITMAN, R. (1902): A new method of treatment for fractures of the neck of the femur. Annals of Surgery, **36,** 746.
WHITMAN, R. (1945): Journal of Bone and Joint Surgery, **27,** 334.
WISE, R. A. (1941): Journal of Bone and Joint Surgery, **23,** 941.

OTHER FRACTURES

ANDERSON, R., MCKIBBIN, W. B., and BURGESS, E. (1943): Intertrochanteric fractures. Journal of Bone and Joint Surgery, **25,** 153.
BARDENHEUER, B., and GRAESSNER, R. (1909): Die Technik der Extensionsverbände. Stuttgart: Ferdinand Enke.
BLAKE, J. A. (1917): Suspension with Extension in the treatment of Fractures of the Limbs. American Journal of Orthopedic Surgery, **15,** 644.
BÖHLER, L. (1945): Die Technik der Knochenbruchbehandlung im Frieden und im Kriege. Vienna: Wilhelm Maudrich.
CHARNLEY, J. C. (1948): Positive Pressure in Arthrodesis of the Knee Joint. Journal of Bone and Joint Surgery, **30-B,** 478.
DE LORME, T. L. (1945): Restoration of Muscle Power by Heavy-resistance Exercises. Journal of Bone and Joint Surgery, **27,** 645.
DUNLOP, J. (1939): Transcondylar Fractures of the Humerus in Childhood. Journal of Bone and Joint Surgery, **21,** 59.
EGGERS, G. W. N. (1948): Internal Contact Splint. Journal of Bone and Joint Surgery, **30-A,** 41.
GAENSLEN, F. J. (1936): The Role of Physical Therapy in Orthopaedic Surgery. Journal of Bone and Joint Surgery, **18,** 559.
HALDEMAN, K. O. (1932): The Role of Periosteum in the Healing of Fractures. Archives of Surgery, **24,** 440.
HALDEMAN, K. O., and MOORE, J. M. (1934): Influence of a local Excess of Calcium and Phosphorus on the Healing of Fractures. Archives of Surgery, **29,** 385.

HAYNES, H. H. (1939): Treating Fractures by Skeletal Fixation of the Individual Bone. Southern Medical Journal, **32,** 720.

HAYNES, H. H. (1943): Skeletal Fixation of Fractures. American Journal of Surgery, **N.S. 59,** 25.

JONES, R. (1913): An Orthopedic View of the Treatment of Fractures. American Journal of Orthopedic Surgery, **11,** 314.

KEY, J. A. (1932): Southern Medical Journal, **25,** 909.

KEY, J. A. (1934): The Effect of a local Calcium Depot on Osteogenesis and Healing of Fractures. Journal of Bone and Joint Surgery, **16,** 176.

KEY, J. A. (1941): Stainless Steel and Vitallium in Internal Fixation of Bone. Archives of Surgery, **43,** 615.

KEY, J. A. (1946): Electrolytic Absorption of Bone due to the use of Stainless Steels of different composition for Internal Fixation. Surgery, Gynecology and Obstetrics, **82,** 319.

KEY, J. A. (1947): Journal of Bone and Joint Surgery, **29,** 1.

KÜNTSCHER, G. (1940): Die Marknagelung von Knochenbrüchen. Archiv für Klinische Chirurgie, **200,** 443.

LANE, W. A. (1893): On the Advantages of the steel screw in treatment of ununited fractures. Lancet, **ii,** 1500.

LANE, W. A. (1894): A method of treating simple oblique fractures of the tibia and fibula more efficient than those in common use. Transactions of the Clinical Society of London, **27,** 167.

LANE, W. A. (1900): The Operative Treatment of Simple Fractures. Lancet, **i,** 1489.

LANE, W. A. (1914): The Operative Treatment of Fractures. Second edition. London: The Medical Publishing Company Limited.

MACEWEN, WM. (1912): The Growth of Bone. Glasgow: J. Maclehose & Sons.

MCLAUGHLIN, H. L., GASTON, S. R., NEER, C. S., and CRAIG, F. S. (1949): Open Reduction and Internal Fixation of Fractures of the long bones. Journal of Bone and Joint Surgery, **31-A,** 94.

MAZET, R. (1943): The Use and Abuse of the Anatomic Splint in the Treatment of Fractures of the lower Extremity. Journal of Bone and Joint Surgery, **25,** 839.

MOORE, J. R. (1944): Delayed Reduction of Fractures. Journal of Bone and Joint Surgery, **26,** 151.

MURRAY, C. R. (1933): The Exact Role of Physical Therapy in the Treatment of Fractures. Surgery, Gynecology and Obstetrics, **56,** 479.

MURRAY, C. R. (1941): The Timing of the Fracture-healing Process. Journal of Bone and Joint Surgery, **23,** 598.

MURRAY, C. R. (1944): Journal of Bone and Joint Surgery, **26,** 307.

PETERSON, L. T. (1947): Fixation of Bones by Plates and Screws. Journal of Bone and Joint Surgery, **29,** 335.

PHEMISTER, D. B. (1935): Bone Growth and Repair. Annals of Surgery, **102,** 261.

POTTS, W. J. (1933): The Role of the Haematoma in fracture healing. Surgery, Gynecology and Obstetrics, **57,** 318.

RUSH, L. V., and RUSH, H. L. (1939): A Technique for Longitudinal Pin Fixation of certain Fractures of the Ulna and of the Femur. Journal of Bone and Joint Surgery, **21,** 619.

RUSSELL, R. H. (1924): Fracture of the Femur. British Journal of Surgery, **11,** 491.

SHAAR, C. M., KREUZ, F. P. Jr., and JONES, D. T. (1944): End-results of treatment of Fresh Fractures by the use of the Stader apparatus. Journal of Bone and Joint Surgery, **26,** 471.

SHERMAN, W. O. (1926): Operative Treatment of Fractures of the Shaft of the Femur with maximum fixation. Journal of Bone and Joint Surgery, **8,** 494.

SOEUR, R. (1946): Intramedullary pinning of Diaphysial fractures. Journal of Bone and Joint Surgery, **28,** 309.

STADER, O. (1937): Preliminary announcement of a new method of treating fractures. North American Veterinarian, **18,** 37.

STEINMANN, F. (1911): Zeitschrift für Orthopädische Chirurgie, **29,** 96.

STREET, D. M., HANSEN, H. H., and BREWER, B. J. (1947): The Medullary Nail. Archives of Surgery, **55,** 423.

THOMAS, H. O. (1886, 1890): Contributions to Surgery and Medicine. London: K. L. Lewis. Part 6—Principles of the treatment of fractures and dislocations. Part 7—Fractures, dislocations, deformities and diseases of the lower extremities.

URIST, M. R., and MCLEAN, F. C. (1941): Calcification and Ossification I: Calcification in the callus in healing fractures in normal rats. Journal of Bone and Joint Surgery, **23,** 1.

URIST, M. R., and MCLEAN, F. C. (1941): Calcification and Ossification II: Control of calcification in the fracture callus in rachitic rats. Journal of Bone and Joint Surgery, **23,** 283.

URIST, M. R. (1942): Calcification and Ossification III: The role of local transfer of bone salt in the calcification of the fracture callus. Journal of Bone and Joint Surgery, **24,** 47.

URIST, M. R., and JOHNSON, R. W. (1943): Calcification and Ossification IV. The healing of fractures in man under clinical conditions. Journal of Bone and Joint Surgery, **25,** 375.

VENABLE, C. S., STUCK, W. G., and BEACH, A. (1937): The Effects on bone of the presence of metals; based upon Electrolysis. Annals of Surgery, **105,** 917.

VENABLE, C. S., and STUCK, W. G. (1938): Electrolysis Controlling Factor in the use of metals in treating fractures. Journal of the American Medical Association, **111,** 1349.

VENABLE, C. S., and STUCK, W. G. (1948): Results of recent studies and experiments concerning metals used in the Internal Fixation of fractures. Journal of Bone and Joint Surgery, **30-A,** 247.

SURGERY OF TENDONS AND OF THE HAND

ALTMAN, H., and TROTT, R. H. (1946): Muscle Transplantation for Paralysis of the Radial Nerve. Journal of Bone and Joint Surgery, **28,** 440.
AUCHINLOSS, H. (1929): Tendon Transplantation. Annals of Surgery, **89,** 145.
BIESALSKI, K., and MAYER, L. (1916): Die physiologische Sehnenverpflanzung. Berlin: J. Springer.
BILLINGTON, R. W. (1922): Tendon Transplantation for Musculospiral (radial) Nerve Injury. Journal of Bone and Joint Surgery, **4,** 538.
BUNNELL, S. (1918): Repair of Tendons in the Fingers. Surgery, Gynecology and Obstetrics, **26,** 103.
BUNNELL, S. (1922): Repair of Tendons in the Fingers. Surgery, Gynecology and Obstetrics, **35,** 88.
BUNNELL, S. (1938): Opposition of the Thumb. Journal of Bone and Joint Surgery, **20,** 269.
BUNNELL, S. (1944): Surgery of the Hand. Philadelphia: J. B. Lippincott Company.
GARLOCK, J. H. (1926): Repair of Wounds of the Flexor Tendons of the Hand. Annals of Surgery, **83,** 111.
HARMER, T. W. (1917, 1926): Tendon Suture. Boston Medical and Surgical Journal, **177,** 808; **194,** 739.
HENZE, C., and MAYER, L. (1916): Experimentelle Untersuchungen über Sehnenverpflanzungen und seidene Sehnen. Zeitschrift für Orthopädische Chirurgie, **35,** 867.
IRWIN, C. E. (1942): Transplants to Thumb to Restore Function of Opposition: End-results. Southern Medical Journal, **35,** 257.
JONES, R. (1908): On Arthrodesis and Tendon Transplantation. British Medical Journal, **i,** 728.
KOCH, S. L., and MASON, M. L. (1933): Division of the Nerves and Tendons of the Hand. Surgery, Gynecology and Obstetrics, **56,** 1.
LANGE, Professor F. (1910): The Orthopedic Treatment of Spinal Paralysis. American Journal of Orthopedic Surgery, **8,** 8.
L'EPISCOPO, J. B. (1939): Restoration of Muscle Balance in the Treatment of Obstetrical Paralysis. New York Journal of Medicine, **39,** 357.
LYLE, H. H. M. (1923): The Disabilities of the Hand and their Physiological Treatment. Annals of Surgery, **78,** 816.
MAYER, L. (1916): Physiological Method of Tendon Transplantation. Surgery, Gynecology and Obstetrics, **22,** 182; 298; 472.
MAYER, L. (1940): Reconstruction of Extensor Digitorum Communis Sheath. Bulletin of the Hospital for Joint Diseases, **1,** 39.
NICOLADONI, K. (1882): Über Sehnentransplantation. Archiv für klinische Chirurgie, **24,** 660.
OBER, F. R. (1932): An Operation to Relieve Paralysis of the Deltoid Muscle. Journal of the American Medical Association, **99,** 2182.
PEABODY, C. W. (1938): Tendon Transposition. An End-result Study. Journal of Bone and Joint Surgery, **20,** 193.
ROYLE, N. D. (1938): An Operation for Paralysis of Intrinsic Muscles of the Thumb. Journal of the American Medical Association, **111,** 612.
SCHWARTZMANN, J. R., and CREGO, Jr., C. H. (1948): Hamstring-tendon Transplantation for the Relief of Quadriceps Femoris Paralysis in Residual Poliomyelitis; Follow-up Study of 134 cases. Journal of Bone and Joint Surgery, **30-A,** 541.
STARR, C. L. (1922): Army Experiences with Tendon Transference. Journal of Bone and Joint Surgery, **4,** 3.
STEINDLER, A. (1919): Operative Treatment of Paralytic Conditions of the Upper Extremity. Journal of Orthopedic Surgery, **1,** 608.
STEINDLER, A. (1930): Flexor Plasty of the Thumb in Thenar Palsy. Surgery, Gynecology and Obstetrics, **50,** 1005.
STEINDLER, A. (1939): Tendon Transplantation in the Upper Extremity. American Journal of Surgery, **N.S. 44,** 260.
VULPIUS, O. (1897): Zur Casuistik der Sehnentransplantation. Münchener medizinische Wochenschrift, **44,** 409.

BIOCHEMISTRY

BANTING, F. G., and BEST, C. H. (1922): Journal of Laboratory and Clinical Medicine, **7,** 464.
BODANSKY, A. (1931): Proceedings of the Society for Experimental Biology and Medicine, **28,** 760.
BODANSKY, A. (1933): Journal of Biological Chemistry, **101,** 93.
BODANSKY, A., and JAFFE, H. L. (1934): Archives of Internal Medicine, **54,** 88. American Journal of Diseases of Children, **48,** 1268.
COLLIP, J. B. (1925): Journal of Biological Chemistry, **63,** 395.
GUTTMAN (1938): Journal of Clinical Medicine, **17,** 473.
HESS (1924): Transactions of the American Pediatric Society, 36.
HUGGINS, C., and CLARK, P. J. (1940): Journal of Experimental Medicine, **72,** 747.

HUGGINS, C., and HODGES, C. V. (1941): Cancer Research, **1,** 293.
HUGGINS, C., SCOTT, W. W., and HODGES, C. V. (1941): Journal of Urology, **46,** 997.
HUGGINS, C., STEVENS, R. E., and HODGES, C. V. (1941): Archives of Surgery, **43,** 209.
KAY, H. D. (1930): Journal of Biological Chemistry, **89,** 249.
KING, E. J., and ARMSTRONG, A. R. (1934): Canadian Medical Association Journal, **N.S. 31,** 376.
MCCOLLUM, E. V., SIMMONDS, N., SHIPLEY, P. G., and PARK, E. A. (1922): Journal of Biological Chemistry, **50,** 5.
RECKLINGHAUSEN, F. VON (1930): Proceedings of the Society for Experimental Biology and Medicine, **27,** 708; 710; 795.
RECKLINGHAUSEN, F. VON (1930): Journal of Biological Chemistry, **88,** 629.
RECKLINGHAUSEN, F. VON (1930): Journal of Experimental Medicine, **52,** 669.
RECKLINGHAUSEN, F. VON (1931): Archives of Pathology, **11,** 207.
ROBISON, R. (1932): The Significance of Phosphoric Esters in Metabolism. New York: The New York University Press.
STEENBOCK (1924): Science (Sept. 5).

OSTEOMYELITIS

ALBEE, F. H., and PATTERSON, M. B. (1930): The Bacteriophage in Surgery. Annals of Surgery, **91,** 855.
BAER, W. S. (1931): The Treatment of Chronic Osteomyelitis with the Maggot. Journal of Bone and Joint Surgery, **13,** 438.
BICK, E. M. (1941): Sulfone Chemotherapy in Hematogenous Osteomyelitis. Surgery, Gynecology and Obstetrics, **72,** 995.
BUCHMAN, J. (1945): Penicillin in the Treatment of Chronic Osteomyelitis. Archives of Surgery, **51,** 81.
CHAIN, E., FLOREY, H. W., *et al.* (1940): Penicillin as a Chemotherapeutic Agent. Lancet, **ii,** 226.
CLEVELAND, M., and GROVE, J. A. (1945): Delayed Primary Closure of Wounds with Compound Fractures. Journal of Bone and Joint Surgery, **27,** 452.
COMPERE, E. L., SCHNUTE, W. J., and CATTELL, L. M. (1945): The Use of Penicillin in the Treatment of Acute Hematogenous Osteomyelitis in Children. Annals of Surgery, **122,** 954.
DICKSON, F. D., DIVELEY, R. L., and KIENE, R. (1941): The Use of Sulfathiazole in the Treatment of Subacute and Chronic Osteomyelitis. Journal of Bone and Joint Surgery, **23,** 516.
DOMAGK, G. (1935): Ein Beitrag zur Chemotherapie der bakteriellen Infektionen. Deutsche Medizinische Wochenschrift, **61,** 250.
FLEMING, A. (1929): On the Antibacterial Action of Cultures of a Penicillium with Special Reference to their Use in the Isolation of B. Influenzae. British Journal of Experimental Pathology, **10,** 226.
HERRELL, W. E., NICHOLS, D. R., and HEILMAN, D. H. (1944): Penicillin: its Usefulness, Limitations, Diffusion and Detection, with Analysis of 150 Cases in which it was Employed. Journal of the American Medical Association, **125,** 1003.
KIRBY, W. M. M., and HEPP, V. E. (1944): Treatment of Osteomyelitis of the Facial Bones with Penicillin. Journal of the American Medical Association, **125,** 1019.
MACNEAL, P. S. (1940): The Use of Asparagin Bacteriophage in the Treatment of Acute Hematogenous Osteomyelitis. Surgery, Gynecology and Obstetrics, **71,** 766.
ORR, H. W. (1927): The Treatment of Acute Osteomyelitis by Drainage and Rest. Journal of Bone and Joint Surgery, **9,** 733.
TRUETA, J. (1939): Treatment of War Wounds and Fractures. London: Hamish Hamilton Ltd.
TRUETA, J. (1943): The Principles and Practice of War Surgery, with Reference to the Biological Method of the Treatment of War Wounds and Fractures. St Louis: C. V. Mosby Company.
WAKSMAN, S. A. (1943): Production and activity of streptothricin. Journal of Bacteriology, **46,** 299.

TUBERCULOSIS

BOSWORTH, D. M., and GREEN, L. A. (1946): Experience with arthrodesis for tuberculosis of the hip. Quarterly Bulletin of the Sea View Hospital, **8,** 39.
BOSWORTH, D. M., and LEVINE, J. (1949): Tuberculosis of the Spine. An analysis of cases treated surgically. Journal of Bone and Joint Surgery, **31–A,** 267.
BRITTAIN H. A. (1941): Ischiofemoral Arthrodesis. British Journal of Surgery, **29,** 93.
CHANDLER, FREMONT, A., and FOX, T. A. (1949): Amputation for Discrepancy of Limb Length in tuberculosis of the Hip. Journal of Bone and Joint Surgery, **31–A,** 420.
FARKAS, A. (1939): A New Operative treatment of tuberculous coxitis in children. Journal of Bone and Joint Surgery, **21,** 323.
GILL, G. G. (1944): The cause of discrepancy in length of the limbs following tuberculosis of the hip in children. Journal of Bone and Joint Surgery, **26,** 272.
HIBBS, R. A. (1930): The treatment of tuberculosis of the joints of the lower extremities by operative fusion. Journal of Bone and Joint Surgery, **12,** 749.

KESTLER, O. C. (1947): Early epiphysial growth arrest about the knee joint following various infectious lesions of the hip. Bulletin of the Hospital for Joint Diseases, **8,** 94.
TRUMBLE, H. C. (1937): Fixation of the hip joint by means of extra-articular bone graft: Late results. British Journal of Surgery, **24,** 728.

ARTHRITIS

ALBRIGHT, F. (1947): Annals of Internal Medicine, **27,** 861.
BAGGANSTOSS, A. H., and ROSENBERG, E. F. (1944): Archives of Pathology, **37,** 54.
BENNETT, G. A., WAINE, H., and BAUER, W. (1942): Changes in the Knee Joint at Various Ages. New York: The Commonwealth Fund.
BICKEL, W. H., YOUNG, H. H., PFUETZE, K. H., and NORLEY, T. (1948): Journal of the American Medical Association, **137,** 682.
BOLAND, E. W. (1947): Annals of the Rheumatic Diseases, **6,** 195.
BUNIM, J. J., MCEWEN, C., SOKOLOFF, S., and WILENS, S. (1950): American Journal of the Medical Sciences, **219,** 174.
CARLISLE, J. M., GIBSON, A., and SCHMATOLLA, E. (1950): Cortisone. Postgraduate Medicine, **8,** 113.
CECIL, R. L. (1940): Proceedings of the Staff Meetings of the Mayo Clinic, **15,** 556.
COPEMAN, W. S. C., and ACKERMAN, W. W. (1944): Quarterly Journal of Medicine, **N.S. 13,** 37.
FORSHAM, P. H., THORN, G. W., PRUNTY, F. T. G., and HILLS, A. G. (1948): Journal of Clinical Endocrinology, **8,** 15.
FREUND, H. A., STEINER, G., LEICHTENTRITT, B., and PRICE, A. E. (1942): American Journal of Pathology, **18,** 865.
GIBSON, H. J., KERSLEY, G. D., and DESMARAIS, M. H. L. (1946): Annals of the Rheumatic Diseases, **5,** 666.
HENCH, P. S., BAUER, W., BOLAND, E. W., CRAIN, D. C., FREYBERG, R. H., GRAHAM, W., HOLBROOK, W. P., LOCKIE, L. M., MCEWEN, C., ROSENBERG, E. F., and STECHER, R. M. (1948): Ninth Rheumatism Review. Annals of Internal Medicine, **28,** 31.
HENCH, P. S. (1949): Annals of the Rheumatic Diseases, **8,** 90.
HENCH, P. S., KENDALL, E. C., SLOCUMB, C. H., and POLLEY, H. F. (1950): Archives of Internal Medicine, **85,** 545.
HENCH, P. S., and ROSENBERG, E. F. (1944): Archives of Internal Medicine, **73,** 293.
KENDALL, E. C. (1949): Proceedings of the Staff Meetings of the Mayo Clinic, **24,** 298.
LI, C. H. (1948): Transactions Conference on Metabolic Aspects of Convalescence. New York: Josiah Macy, Jr., Foundation.
LUDWIG, A. O., SHORT, C. L., and BAUER, W. (1943): New England Journal of Medicine, **228,** 306.
MEYER, K. (1947): Physiological Reviews, **27,** 335.
RAGAN, C. (1948): Annals of the Rheumatic Diseases, **7,** 35.
RALLI, E. P. (1949): Transactions Conference on Adrenal Cortex. New York: Josiah Macy, Jr., Foundation.
REICHSTEIN, T. (1936): Acta Helvetica Chemica, **19,** 1107.
ROSE, H. M., RAGAN, C., PEARCE, E., and LIPMAN, M. O. (1948): Proceedings of the Society for Experimental Biology and Medicine, **68,** 1.
SELYE, H, (1946): Journal of Clinical Endocrinology, **6,** 117.
SHORT, C. L., and BAUER, W. (1942): New England Journal of Medicine, **227,** 442.
SLOCUMB, C. H. (1943): Clinics, **2,** 169.
STECHER, R. M. (1941): American Journal of the Medical Sciences, **201,** 801.
STEINBROCKER, O., SPITZER, N., and FRIEDMAN, H. H. (1948): Annals of Internal Medicine, **29,** 22.
STEINBROCKER, O., TRAEGER, C. H., and BATTERMAN, R. C. (1949): Journal of the American Medical Association, **140,** 659.

CEREBRAL PALSY

CHANDLER, F. A. (1933): Re-establishment of normal leverage of the patella in knee flexion deformity in spastic paralysis. Surgery, Gynecology and Obstetrics, **57,** 523.
COLLIER, JAMES (1924): The Pathogenesis of Cerebral Diplegia. Brain, **47,** 1.
DAVIDIAN, HAGOP (1938): Athetosis (Review of the literature with clinical report of a case). Alienist and Neurologist, **36,** 339.
DURHAM, H. A. (1938): A Procedure for the correction of internal rotation of the thigh in spastic paralysis. Journal of Bone and Joint Surgery, **20,** 339.
FREUD, SIGMUND (1897): Die Infantile Cerebrallähmung. Vienna: Alfred Hölder.
GREEN, W. T. (1942): Tendon Transplantation of the Flexor Carpi Ulnaris for pronation-flexion deformity of the wrist. Surgery, Gynecology and Obstetrics, **75,** 337.
GREEN, WM. T., and MCDERMOTT, LEO J. (1942): Operative treatment of cerebral palsy of spastic type. Journal of the American Medical Association, **118,** 434.
MCCARROLL, H. R., and SCHWARTZMANN, J. R. (1943): Spastic Paralysis and allied disorders. Journal of Bone and Joint Surgery, **25,** 745.

PHELPS, W. M. (1938): The care and treatment of cerebral palsies. Journal of the American Medical Association, **111,** 1.

PHELPS, WINTHROP MORGAN (1946) Recent significant trends in the care of cerebral palsy. Lectures on Regional Orthopedic Surgery and Fundamental Orthopedic Problems. (Reprint from Southern Medical Journal, **39,** 132.)

SCHWARTZ, PH., and FINK, LOTTE (1926): Morphologie und Entstehung der geburtstraumatischen Blutungen in Gehirn und Schädel des Neugeborenen. Zeitschrift für Kinderheilkunde, **40,** 427.

STOFFEL, ADOLF (1913): The treatment of spastic contractures. American Journal of Orthopedic Surgery, **10,** 611.

MUSCLE RELAXANTS

BENNETT, A. E. (1941): Clinical investigations with curare in organic neurologic disorders. American Journal of the Medical Sciences, **202,** 102.

BERGER, F. M., and BRADLEY, W. (1946): The pharmacological properties of A:B Dihydroxy-(2-Methylphenoxy)-propane (myanesin). British Journal of Pharmacology, **1,** 265.

BERGER, F. M., and SCHWARTZ, R. P. (1948): Oral " Myanesin " in treatment of spastic and hyperkinetic disorders. Journal of the American Medical Association, **137,** 772.

BURMAN, M. S. (1938): Curare therapy for the release of muscle spasm and rigidity in spastic paralysis and dystonia musculorum deformans. Journal of Bone and Joint Surgery, **20,** 754.

BURMAN, M. S. (1939): Therapeutic use of curare and erythroidine hydrochloride for spastic and dystonic states. Archives of Neurology and Psychiatry, **41,** 307.

SCHLESINGER, E. B. (1946): Recent advances in the use of curare in clinical practice. Bulletin of the New York Academy of Medicine, **22,** 520.

SCHLESINGER, E. B., and RAGAN, C. (1946): " Muscle spasm " in acute low back pain and similar syndromes. A new method of treatment with curare (d-tubocurarine in oil and wax). American Journal of Medicine, **1,** 621.

SCHLESINGER, E. B., DREW, A. L., and WOOD, B. (1948): Clinical studies in the use of myanesin. American Journal of Medicine, **4,** 365.

SCHLESINGER, E. B., and STINCHFIELD, F. S. (1950): Journal of Bone and Joint Surgery (in press).

STEPHEN, C. R., and CHANDY, J. (1947): Clinical and experimental studies with myanesin. Canadian Medical Association Journal, **57,** 463.

ADMINISTRATION

BICK, E. M. (1948): Source Book of Orthopaedics. Baltimore: The Williams and Wilkins Company.

FRAMPTON, MERLE E., and ROWELL, HUGH GRANT (1938): Education of the Handicapped. Yonkers, N.Y.: The World Book Company.

KEESECKER, WARD W. (1929): Digest of Legislation for Education of Crippled Children. Bulletin No. 5 of the United States Office of Education. Washington, D.C.: Government Printing Office.

MACDONALD, MARY E. (1944): Federal Grants for Vocational Rehabilitation. Chicago, Illinois: University of Chicago Press.

MCMURTRIE, DOUGLAS C. (1916): A Study of the Character and Present Status of Provision for Crippled Children in the United States. American Journal for Care of Crippled, item 2, p. 38.

SHANDS, Jr., A. R., (1942): Directory of Hospitals and Convalescent Institutions engaged in work for crippled children. Elyria, Ohio: The National Society for Crippled Children in the United States of America.

SOLENBERGER, EDITH REEVES (1914): Care and Education of Crippled Children in the United States. New York: Survey Associates.

White House Conference on Child Health and Protection (1930): New York and London: The Century Co., 1933.

Vol. IV A—Organization for the Care of Handicapped Children—Committee on National, State and Local Organization for the Handicapped. Section IV—The Handicapped: Prevention; Maintenance Protection.

Vol. IV B—The Handicapped Child—Committee on Physically and Mentally Handicapped. Section IV—The Handicapped: Prevention; Maintenance; Protection.

Public School Classes for the Crippled Children (1918): Bulletin No. 10 of the United States Office of Education. Washington, D.C.: Government Printing Office.

A Digest of Federal and State Legislation Affecting Crippled Children and the Physically Handicapped (1938): Elyria, Ohio: National Society for Crippled Children.

The National Health Survey 1935–36 (1938): The Prevalence and Causes of Orthopedic Impairments. National Institute of Health, U.S. Public Health Service, Washington, D.C.

Twenty-fourth Annual Report of the Secretary of Labor, 1936: pp. 109–137.

Twenty-fifth Annual Report of the Secretary of Labor, 1937: pp. 98–127.

Economic Security Act Hearings before the Committee on Finance, U.S. Senate 74th Congress—First Session on S1130, Part 6 (1935): Washington, D.C.: United States Government Printing Office.

ORTHOPAEDICS IN CONTINENTAL EUROPE 1900-1950

THE CHANGING PATTERN

HARRY PLATT, MANCHESTER, ENGLAND

Professor of Orthopaedic Surgery and Director of the Department of Orthopaedics, University of Manchester

In the opening years of the twentieth century the practice of orthopaedics in Continental Europe could be seen to reflect two distinct trends in the evolution of surgical specialism. In France and Belgium, and the middle European countries which looked to French surgery for example and precept, orthopaedics was regarded as an integral part of the surgery of childhood—" Chirurgie Infantile et l'Orthopédie." In the leading university medical schools in France there were already professorial chairs in this subject, as indeed there are to-day. Thus, continental orthopaedic surgeons who conformed to the French pattern were for the most part general surgeons devoting their main activities to the study and treatment of surgical maladies of the growth period. It could be said in their favour that they looked at the child as a whole. By contrast, in Germany and in countries where German surgical influence was predominant, orthopaedics had long been a surgical specialism in its own right; but in the main it was still nineteenth century orthopaedics as practised by men who often had little claim to the status of general surgeon. The German orthopaedists were concerned primarily with the treatment of deformities resulting from crippling disease and injury in patients of all ages. Their therapeutic armamentarium embraced a combination of mechanical, re-educational and, where necessary, relatively minor operative measures. It was a field of practice in which there was emphasis on conservative methods of treatment.

In many countries both the French and German patterns of orthopaedic practice flourished side by side. But throughout Europe, at this period and for many years after, the practice and teaching of the surgery of injuries, and of the major reconstructive surgery of the locomotor system, remained within the ambit of the omnicompetent general surgeon. We are therefore called upon to note the important contributions to the corpus of knowledge on which the art and science of present day orthopaedics is based of many whose surgical activities transcended the somewhat narrow scope of the " older orthopaedics."

After the first world war the change in pattern of orthopaedic practice in Great Britain, whereby its sphere was extended to include the treatment of fractures and allied injuries, inevitably began to influence the strategy of continental orthopaedics. This was one of the outstanding movements inspired by Sir Robert Jones, at that time acclaimed by common consent as the international leader. In Italy, under the guidance of the incomparable Vittorio Putti (1880–1940), special orthopaedic institutions and university clinics gradually assumed responsibility for the wider field of modern orthopaedics and the Rizzoli Institute in Bologna became a Mecca for young surgeons from all over the world, more especially from the Latin-American countries. In Holland, where the German tradition had long held sway, Murk Jansen (1867–1935) of Leiden encountered stiff but ineffectual opposition from some of the leading general surgeons of that country in his early efforts to establish the British and American pattern. Murk Jansen was a powerful fighter in any good cause and when in 1928 he devoted half his private fortune to the building and equipping of the Anna Kliniek, the operating theatre suite on the upper floor was designed on a lavish scale. Its windows could be seen from many parts of the old university city of Leiden and were impishly believed by

Jansen to provide a much needed counter-irritant to the professor of surgery as he passed on his bicycle to and from duties at the University Hospital!

Opposition to an expansionist policy was seen in its most uncompromising form in Germany, where in 1931 the professors of surgery issued a manifesto in which they defined the scope of the practice and teaching of orthopaedics to be followed in the university medical schools. For a time at least, German orthopaedic surgeons as a corporate body seemed willing to submit to restrictions imposed from without, and at the general assembly of the third congress of the Société Internationale de Chirurgie Orthopédique at Bologna in 1936 the German members voted as a minority bloc against the proposal to add " et de Traumatologie " to the title of the society.

The old arrangement of linking orthopaedics to the surgery of children still holds in France but is no longer sacrosanct. The first important break with tradition was seen some years before the second world war when Paul Mathieu was elected to a new chair of adult orthopaedics in the Paris School of Medicine, with his clinic at the Cochin.

We now face a situation in which the sphere of modern orthopaedics has become so wide and complex that it is questionable whether it can be encompassed adequately in the practice of any one man, or provided for in a balanced fashion under the roof of any single clinic or institution. There is to-day a real danger that the contemporary preoccupation of the coming generation of orthopaedic surgeons with the surgery of trauma may lead to a lessening of interest, and loss of skill, in the treatment of the more tedious and still unsolved problems we have inherited from the older orthopaedics. It may well be that we shall see the future emergence of two main groups of orthopaedic surgeons—the first consisting of those who devote the greater part of their time to the practice of " cold " orthopaedics with its ever-widening range of major reconstructive surgical procedures, but who maintain a firm link with traumatology; and a second group of those who are concerned primarily with the treatment of injuries of the locomotor system in large accident services, but still retain a link with " cold " orthopaedics.

LANDMARKS IN PROGRESS

History has been defined as the story of the vicissitudes of human affairs. It is fitting, therefore, that we should chronicle the pattern of events in any special field of medicine in a particular epoch in terms of the actions and achievements of men who made a deep impression on their own generation, and whose contributions to knowledge seem likely to influence thought and practice in generations to come. In the field of orthopaedics we have also to recognise that the contributions of many of its leading exponents have not been concerned solely with the art and science of orthopaedic practice. In all European countries, orthopaedic surgeons have played a prominent part in arousing public interest in the social needs of the crippled and deformed; they have in truth been pioneers in what is now popularly termed social medicine.

FRANCE

In France the first outstanding figure to be noted in the opening years of the twentieth century is Edouard Kirmisson (1848–1927) who from 1901 to 1919 occupied the Chaire de Clinique Chirurgicale Infantile at the famous children's hospital of Paris—the Clinique des Enfants-Malades—and was the acknowledged doyen of French Orthopaedics. His textbook on *Acquired Deformities of the Locomotor System in Childhood and Adolescence*, published in 1902, became the standard work on this subject for the next generation. It was a companion volume to his earlier work on the *Surgical Treatment of Congenital Deformities*, published in 1898. Among Kirmisson's many personal communications we may note the introduction of osteotomy for irreducible congenital dislocation of the hip, and his recognition of the association of displacement of the upper femoral epiphysis with obesity of the hypopituitary type. His dominant influence on the development of orthopaedics in France was seen early

in his career in his share in the foundation of the *Revue d'Orthopédie* (1890), a journal so long and ably edited in our own day by Albert Mouchet. Some years later Kirmisson was the moving spirit in launching the French Orthopaedic Society of which he was elected the first president.

The university chair associated with the Enfants-Malades has long been regarded as the blue riband of French orthopaedics and it is not surprising to find among the successors of Kirmisson men who attained a European reputation. Louis Ombrédanne who held this position until 1942 is happily still with us, the elder statesman of continental orthopaedics. His tall distinguished figure has lent dignity and grace to the several congresses of the International Orthopaedic Society both before and since the second world war, and his election in 1948 as President-Emeritus was a fitting tribute to the qualities of his leadership. The design of the new surgical clinic of the Enfants-Malades has been one of his notable achievements and, true to the tradition of the premier French chair of orthopaedics, he has expounded his wide clinical experience in the pages of two comprehensive text-books—the classical five volume *Traité de Chirurgie Orthopédique*, edited in collaboration with Paul Mathieu (1935), and *Précis Clinique et Opérative de Chirurgie Infantile*, of which a fifth edition, revised and augmented, was published last year.

Of Jacques Leveuf (1886–1948), who succeeded Ombrédanne, there is little one can add at this moment to the tributes paid to him in recent memorial notices in this Journal.* It was the sad fate of this man of dynamic personality to hold the coveted position at the Enfants-Malades for a very short time, and his death at the height of his powers deprived continental orthopaedics of one who still had a significant message to deliver. Leveuf approached every subject in a critical and sceptical fashion. His brilliant and provocative studies on Volkmann's ischaemic contracture, osteomyelitis, and congenital dislocation of the hip, culminating in his monograph *Luxations et Subluxations Congénitales de la Hanche*, despite the unorthodox views therein expounded with such vehemence, will become the base from which further advances will be made in these subjects in years to come.

From Paris we may turn aside for a moment to the great provincial medical school of Lyons and there take note of a man of quiet dignity and high culture—Gabriel Nové-Josserand (1868–1949). Nové-Josserand was brought up in the great tradition of Ollier and was appointed to the first professorial chair in orthopaedics in Lyons in 1921. He will be remembered in Great Britain as president of the second congress of the International Orthopaedic Society held in London in 1933. One of the subjects among many to which he applied his wisdom and judgment was a survey of the results of manipulative reduction of congenital dislocation of the hip joint in a long series of cases. With Louis Tavernier, his successor in the chair at Lyons, Nové-Josserand produced a monograph on malignant tumours of bone in 1927, a work which at that time gave a concise account of contemporary knowledge on this subject. Professor Tavernier, whose term of office in the Lyons chair has only recently come to an end, was one of the first French surgeons to deal adequately with the subject of internal derangement of the knee and, in collaboration with Mouchet, he published *Pathologie des Menisques du Genou* in 1927. In recent years he has made valuable contributions to the surgery of osteoarthritis of the hip joint with particular advocacy of the operation of denervation of the hip joint.

Orthopaedics is also indebted to the School of Lyons for the inspiring contributions of one who throughout his career has remained in the true sense a general surgeon—the world famous René Leriche. During his tenure of the chair of surgery at Strasbourg (1925–1939) Leriche became one of the great master-surgeons of Europe. His world-wide influence on surgical thought continues to be radiated from Paris where he now occupies the chair once held by Claude Bernard at the Collège de France. Leriche's pioneer work on the surgery of the vascular system, peripheral nerve injuries, and the surgical problems of pain, has

* Journal of Bone and Joint Surgery (1948). Obituary, Professor Jacques Leveuf, **30–B**, 723.

throughout its various phases of exposition become an integral part of the background of orthopaedic knowledge and practice. But it is his classic work on the physiology and pathology of bone which lies nearest to the heart of modern orthopaedics. Fundamental views on bone formation, expounded so eloquently by Leriche and his collaborator Policard in 1926, have not gained acceptance in their entirety, but this work indeed constitutes an epoch in the evolution of twentieth century orthopaedics. More recently, in his inaugural lectures at the Collège de France, Leriche reviewed in philosophic and synoptic fashion the whole range of skeletal disorders.

The foundation in the second half of the nineteenth century of the Maritime Hospital at Berck on the Normandy coast, under the aegis of the Paris hospital system, has been one of the most potent influences in determining the trend of French orthopaedic practice. For more than half a century this hospital of nearly one thousand beds, devoted primarily to the treatment of tuberculosis of bones and joints but always with a small admixture of other cases, has provided a unique aggregation of material and formed the basis of a continued stream of clinical studies from successive surgeons-in-chief and their assistants. The classic work of Ménard in 1900 on the pathological mechanics of Pott's disease comes first to mind; its significance was recognised fully by Alfred Tubby in his incomparable text-book published in 1912. Ménard remained at the Maritime Hospital throughout the whole of his long active career, unlike his successors who have been appointed in turn from among the " Chirurgiens des Hôpitaux de Paris " and have returned to the French capital after holding the Berck command for a limited period. Although Ménard's teaching belongs to late nineteenth century orthopaedics, and we are now in the era of revival of a more radical surgical attitude towards the treatment of surgical tuberculosis, his original observations are still of paramount importance. Among his most distinguished pupils who have enhanced the reputation of the Berck school was Jacques Calvé, now living in retirement in the United States. Calvé's name (1910) is of course linked inseparably with Legg of Boston (1909) and Perthes of Tübingen (1910) in the first recognition of " pseudo-coxalgie " as a clinical entity. For the discovery of that much less common lesion osteochondritis of the vertebral bodies (1922) Calvé's priority is undisputable, and his further observations on this condition were presented in the essay he contributed in 1928 to the *Robert Jones Birthday Volume*. Calvé made many important communications in the period between the two world wars, a number of them in collaboration with his pupil and assistant, Galland, a man of mechanical genius. His carefully planned technique for the relief of Pott's paraplegia by aspirating the intra-spinal abscess by means of a curved cannula introduced through the intervertebral canal seemed at first to be a valuable addition to our therapeutic resources (1922). It was disappointing to find that after patient trial the method proved to be applicable to so few cases of paraplegia. Perhaps Calvé's most striking contribution to orthopaedic literature was his study with Galland of the pathological mechanics of Pott's disease in the *Revue d'Orthopédie*. In this article we can find a masterly restatement of the basic teaching of Ménard in its modern perspective and more particularly a critical examination of the rationale of the operation of spinal fusion. We must also remember, as Herbert Brittain has reminded us, that Calvé predicted the development of ischio-femoral arthrodesis of the hip.

During the period under consideration many surgical pilgrims to Berck became aware of the impact on orthopaedic practice of that redoubtable and colourful personality Frederic Calot. Calot owed nothing to the Ménard dynasty, or to the Paris hospital system. He had established his own independent clinic which became known far and wide as the result of his writings and more especially the attractive illustrations in his popular monograph *Orthopédie Indispensable*, a work published in Paris in 1909 which went into nine editions. Calot was an exponent of the injection of cold abscesses with iodoform oil. He wrote enthusiastically about the results in his own hands of the manipulative reduction of congenital hip dislocations and in this field regarded himself as a rival of the great Adolf Lorenz. His considerable

experience of hip joint anomalies led him to conclude that unrecognised congenital subluxation was a basic stigma determining many affections of the hip joint at a later stage, such as pseudo-coxalgia in children and osteoarthritis in adults. Calot was the type of virtuoso to be found at every period in all branches of surgery—the man who founds no school and leaves behind no pupils; but his influence on the practice of orthopaedics cannot be discounted.

In due course the position of surgeon-in-chief at the Maritime Hospital provided Etienne Sorrel with a wealth of material of which he made full use during ten fruitful years after the first world war before returning to Paris to take charge of the surgical clinic at the Trousseau. It was during this period that his charming and talented wife, Madame Sorrel-Dèjerine, wrote the monograph on Pott's paraplegia which will long remain a classic of orthopaedic literature. During the past twenty-five years both Sorrel and his wife have maintained a steady output of clinical contributions ranging widely over the field of children's orthopaedics. Sorrel himself has played an influential part in the affairs of the International Orthopaedic Society, and this year has attained the signal honour of being elected president of that ancient foundation, the Académie de Chirurgie de Paris.

The first decade of the twentieth century witnessed a number of noteworthy contributions to the treatment of fractures by Pierre Delbet (1865). It was in 1906 that this distinguished Parisian general surgeon first began to practice internal fixation of intracapsular fractures of the femoral neck by means of a screw introduced under X-ray control. At this time also Delbet was advocating early weight-bearing in fractures of the leg bones. Neither method gained immediate or universal acceptance, and it was not until some twenty years later that Smith-Petersen introduced his tri-flanged pin (1929), and Böhler in Vienna made fashionable the early ambulatory treatment of lower limb fractures.

Reference has already been made to the election of Paul Mathieu to the first Chair of Adult Orthopaedics in Paris, a post which he has relinquished only recently. Mathieu has been a wise counsellor in the affairs of French orthopaedics for many years and the contemporary use of acrylic-resin femoral heads in reconstructive surgery of the hip joint, in the hands of his pupils, Jean and Robert Judet, and of his successor, Merle D'Aubigné, is a development of his own earlier work in this operative field.

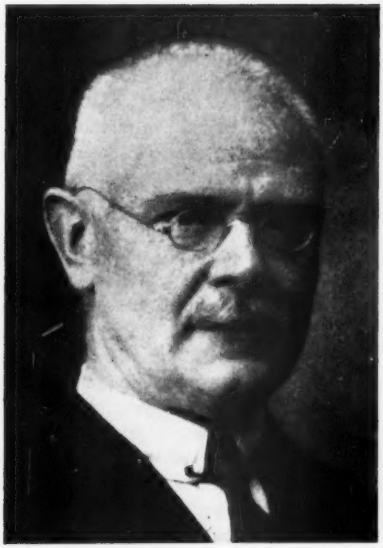
In this brief sketch of some notable events in the evolution of orthopaedics in France during the first half of the twentieth century it has not been possible to pay tribute to many who made their contribution. We do not forget the part played by such men as Fröhlich of Nancy (1867–1945), Henri Judet (1874–1942), Le Fort of Lille, Rocher of Bordeaux and Albert Mouchet of Paris.

BELGIUM

In Belgium, as elsewhere, modern orthopaedics exhibits the features of a mixed ancestry. There is first the old French tradition of *chirurgie infantile* as exemplified in the professorial chair in Brussels at the Saint Pierre Hospital. This post was filled with distinction in the early part of the century by Jules Lorthioir (1864–1931), friend of Robert Jones and father of Paul Lorthioir who is well known to British surgeons by his devotion to the affairs of the International Society of Surgery and the International Orthopaedic Society. The elder Lorthioir was succeeded in 1916 by Adolphe Maffei (1872–1945), a sound practitioner and teacher of the art of orthopaedics but, above all, a man of goodwill and a delightful host who was held in warm regard by all members of the International Orthopaedic Society. Maffei suffered the cruel fate of internment during the German occupation of Brussels and he died in the notorious camp at Belsen.

Belgian orthopaedics also bears the imprint of the pioneer work on internal fixation of fractures by that great European surgeon Lambotte of Antwerp, the counterpart of our own Arbuthnot Lane. A delightful tribute with a pen picture of this famous veteran was given by his pupil and assistant Jean Verbrugge at the annual meeting of the British Orthopaedic Association in 1949. Robert Danis, recently retired from the chair of surgery in Brussels, is

LOUIS OMBREDANNE



MÜRK JANSEN (1867–1935)

VITTORIO PUTTI (1880–1940)

another general surgeon who throughout his career has been an exponent of osteosynthesis and has devised a variety of instruments, plates, screws and nails for this purpose. Danis has recently brought together his teaching and experience in this field of traumatic surgery in a monograph published in Paris last year—*Théorie et Pratique de L'osteosynthèse.*

The Belgian orthopaedic surgeons to-day compose a small but lively body of men who reflect collectively the various facets of modern orthopaedics—traumatology, surgical tuberculosis, children's orthopaedics and the rheumatic diseases. Prominent amongst them is the genial Jean Delchef, known far and wide as the secretary-general of the International Orthopaedic Society and a frequent and welcome visitor to this country at meetings of the British Orthopaedic Association.

HOLLAND

The story of Dutch orthopaedics in the first thirty years of this century is, in simple truth, the story of Mürk Jansen (1867–1935). It is difficult to praise too highly the achievements of this remarkable man. It was not merely that he fought for the recognition of orthopaedics as an expanding surgical universe; it was not his superb command of many languages, wide culture, or international friendships—all these lambent qualities are still fresh in the memory of those who knew him: it was the inspiring example of a questing mind that was his outstanding gift to our generation. He was perhaps the most prolific writer of the European orthopaedic surgeons of his day. From his earliest years he became inquisitive about the genesis of congenital deformities, and to the end he held on to his theory of the harmful effects on the embryo of abnormal infolding of the amnion. Despite oft-repeated arguments his thesis gained little support; but he was nearer than he realised to a fundamental discovery in his concept of maternal " fatigue " as the determining cause of stunting of growth in the embryo (1921). Jansen's work on bone-formation and bone-growth was a much needed critique of the somewhat over-simplified ideas which clinicians and others had extracted from the classical studies of Culmann and Julius Wolff in the nineteenth century. Mürk Jansen was essentially the biologist in action. As an operating surgeon, an activity to which he came late, he was largely self-taught, but his years as a teacher of anatomy guided his hands along lines of safety. It is good to know, as many of the members of the International Orthopaedic Society became aware during the congress at Amsterdam in 1948, that the Anna Kliniek is to-day an orthopaedic centre in which the whole range of modern reconstructive surgery can be witnessed. The same is true of the clinic at the Wilhelmina Hospital in Amsterdam now directed by La Chapelle. We also pay tribute to the work of Van Assen of Rotterdam, an exponent of the older orthopaedics, who died on the eve of the Amsterdam congress of which he was to have been vice-president.

ITALY

The foundations which shaped the ultimate pattern of modern orthopaedics were well and truly laid in Italy. By the end of the nineteenth century there were two great orthopaedic institutions in Milan and Bologna. In Milan, the Istituto dei Rachitici which opened its doors in 1881 was for some years devoted to the orthopaedics of children but, as new accommodation became available, its sphere of activity was extended to deal with crippling diseases in the adult. Under the direction of Ricardo Galeazzi, a man of great personal distinction and dignified bearing, the Milan Institute became one of the little group of European orthopaedic centres which attracted surgical pilgrims during the period between the two world wars. The amazing number of congenital hip dislocations treated each year in the Milan clinic had to be seen to be believed. The treatment of this deformity was evidently regarded as an every-day affair by Galeazzi, for the subject formed the basis of few clinical studies from the Milan centre. Galeazzi has been one of the comparatively few orthopaedic surgeons of high standing in modern times to devote his energies to the solution of that somewhat unrewarding problem, the correction of structural scoliosis. His first report on the results of his own carefully devised plan of attack was made to the German Orthopaedic Congress in 1913. A full

description of the method can be found in the second edition of " Jones and Lovett " (1929). There can be no doubt that in many children, and even in adolescents with spines still plastic, a considerable degree of true correction was obtained. The method was tedious; it demanded a great deal of time and physical labour; and it was not free from risks. The same had been true of both the Abbot and Mackenzie Forbes methods of forced correction which in turn had had their day. Although Galeazzi belonged to a generation who had entered the practice of the older orthopaedics, he moved with the times and in due course became interested in the organisation of a centre for the treatment of industrial injuries and road accidents. One of his most instructive contributions to this field of orthopaedics was a clinical and experimental study of semilunar cartilage lesions of the knee joint in which he demonstrated how unusual types of meniscus injury could be produced by powerful violence transmitted through the cruciate ligament system.

The story of the foundation of the Istituto Rizzoli in Bologna has often been told—how an historic old Olivetan monastery on a hill in the outskirts of the city was purchased in 1880 by Francesco Rizzoli and adapted for use as an orthopaedic hospital. Rizzoli, who had at one time been professor of surgery in the University of Bologna, left his entire fortune for the conversion of the monastery to its new purpose and for its partial endowment—surely an example of one of the material gifts of general surgery to orthopaedics. Under Panzeri, its first director, the Institute reflected faithfully the current pattern of nineteenth century orthopaedics; but at the turn of the century a change came over the scene with the appointment of Alessandro Codivilla, a general surgeon who was to become founder of the modern movement in Italian orthopaedics. In the short span of years allotted to him, for he died in his early fifties, Codivilla left the imprint of his teaching on almost every phase of orthopaedic practice. He was probably the first to develop the technique of preserving the gliding mechanism in tendon transplantations—later to be known as the " physiological " method (Biesalski and Mayer); he was an early exponent of leg lengthening, an experiment in surgery which led him to the use of skeletal traction in the treatment of fractures; and he set out to improve the standards of technique of amputation. At first it seemed that the early death of this great master-surgeon would slow the tempo of expansion of the field of orthopaedics; but his successor was there to hand, the young Vittorio Putti who for some years had been Codivilla's chief assistant and was destined to outshine his master. After a brief interregnum, Putti was appointed director of the Institute at the age of thirty-one. He was born in Bologna, the son of a surgeon practising in that city; his mother was a poetess much honoured in the province of Emilia. He began the study of medicine with all the advantages of a cultured home in an ancient university city. The influence of this early background was manifest throughout his career in his love of books, his pride in the history of Italian medicine, and his ripe scholarship. During the first world war, under the leadership of this brilliant young surgeon, the Rizzoli Institute became a centre of reconstructive surgery and rehabilitation for military patients. By the time he had reached the age of forty, Putti's contributions to the surgery of peripheral nerve injuries, and his work on the technique of cine-plastic amputations and on arthroplasty of the knee joint, had placed him in the front rank of European surgeons.

Between the two world wars the Rizzoli Institute became an orthopaedic Mecca. New buildings were added from time to time but the historic original block, which contained the beautiful library, was conserved carefully. Putti made many generous gifts from his earnings in private practice towards the cost of these extensions, and the library housed his ever-increasing collection of incunabula. As a collector of ancient medical books he was soon to rank with Harvey Cushing.

To the Rizzoli Institute during those twenty years after the first world war, years so rich in achievement, Putti attracted a succession of talented young men, many of whom were later to take charge of new orthopaedic clinics in the smaller university cities. During their apprenticeship they enjoyed opportunities for intellectual adventure which were unique,

THE LIBRARY OF THE ISTITUTO RIZZOLI, BOLOGNA

for in the library could be found the recorded lore of orthopaedics past and present, and the facilities for clinical investigation and later for pathological and experimental research were unrivalled.

It could be said of Putti himself that he illuminated every subject he touched. We have already referred to his earlier contributions. To these may be added his monograph on bone tumours published in 1927 in which he recorded the results of extensive resection in cases where amputation had been regarded as inevitable; his studies on intervertebral arthritis as a cause of the backache-sciatica syndrome recorded in 1930; and his last major work, the monograph on fractures of the neck of the femur published in 1940 in which he expounded the principles and technique of internal fixation by means of a screw which exerted an impacting and not a disimpacting force. Many other striking contributions could be cited.

But it is for his work on congenital dislocation of the hip joint that Putti's fame will endure. His first communication on the early diagnosis and treatment of the deformity in infants (1927) was a contribution to preventive orthopaedics that led to the organisation of publicity and propaganda in a population suffering a serious social problem by reason of the high incidence of this deformity. His superb atlas on the anatomy of the deformity based on a unique series of dissected specimens (1935) has already taken its place among the classics of twentieth century orthopaedic literature. It was left to one of Putti's most brilliant pupils, Oscar Scaglietti, to prepare for submission to the International Orthopaedic Congress in 1939 a review of the results of manipulative reduction in 3,628 cases of congenital hip dislocation treated in the Rizzoli Institute between the years 1899 and 1938.

Of Putti the man, the savant and bibliophile, we have already had a glimpse. Like Mürk Jansen, he was polylingual—an accomplishment that gave these two remarkable men a commanding influence in the affairs of international orthopaedics during the years between the two wars, which was indeed a golden age of orthopaedic surgery. When in the fullness of time the story of European orthopaedics in the first fifty years of the twentieth century comes to be written by those to whom the heroes of this age are no longer real men but shadowy figures in history—and if, as seems likely, it will be proclaimed the age of Robert Jones, surely with his name will be linked that of the great Vittorio Putti.

The prestige of the Rizzoli Institute shows no signs of decline under its new director, Francesco Delitala, who has much of the same zest for the history of medicine as his great predecessor. In Rome the development of orthopaedics has followed a less spectacular course; it has had to compete for a place in the sun with general surgery represented powerfully by such brilliant Italian surgeons as Bastianelli and Alessandri. The new University Orthopaedic Clinic, which had been opened shortly before the International Orthopaedic Congress met in Rome in 1936, is a beautifully designed and equipped institute under the direction at that time of Dalla Vedova, a man of retiring disposition but none the less an able exponent of the art of modern orthopaedics.

SCANDINAVIA

In its earliest stages Scandinavian orthopaedic practice developed largely along German lines. Special hospitals for the treatment of cripples were set up, often under the aegis of voluntary organisations. These institutions provided not only beds and out-patient clinics but workshops which became centres for the supply of orthopaedic appliances and artificial limbs for a considerable hinterland, and were used also for vocational training. Patrick Haglund (1870-1937) of Stockholm was for many years the recognised leader among a small and slowly expanding group of Scandinavian orthopaedists. His earlier training had been in German orthopaedic clinics and on returning to Stockholm he began almost single-handed to create an orthopaedic centre in premises which consisted of a number of houses adapted for the purpose. This was the forerunner of the modern orthopaedic hospital to be erected thirty years later on the site of the new medical centre of the Caroline Institute—the Medical College of Stockholm. In the year of opening of the new hospital Haglund reached

the age of sixty-five and thus was deprived of the joy of working in an institute to the design of which he had given so much thought. To the somewhat primitive and crowded premises of the old Vanforeanstalten, Haglund had attracted patients from all over Sweden and he made good use of this material in his writings and in the training of his assistants. Haglund was a man of high culture, widely read, and a lover of music. His monograph on the *Principles of Orthopaedics* (1923) was a scholarly work. It was written in German and no English translation ever became available. For many years the great majority of children with congenital dislocation of the hip joint in Sweden found their way to Haglund and it was this large series of cases that formed the basis of the notable survey of late results of treatment published in 1941 by a former pupil—Erik Severin. Another important contribution which came from the old clinic was the review by Harald Nilsonne of the remarkable results of cuneiform osteotomy in an unusually large series of cases of that uncommon deformity infantile coxa vara.

Henning Waldenström, who followed Haglund as director of the new Orthopaedic Institute and in the professorial chair, held these appointments for a comparatively short term of years before reaching the statutory age of retirement; but during that time he gathered around him a group of able young men who are now maintaining the high reputation of Swedish orthopaedics. Waldenström's main clinical investigations have been centred on a study of the evolutionary changes in those affections of the hip joint in which flattening of the upper end of the femur is the final stage—coxa plana. It seems clear that by 1909 he had already recognised, independently of Legg, Calvé and Perthes, that pseudo-coxalgia was a non-tuberculous lesion of the hip. In 1938 he published a brief note on a condition of the hip joint which had hitherto escaped recognition as a clinical entity and which he called coxa valga magna luxans. Now in retirement, enjoying both leisure and travel, Waldenström retains his amazingly youthful appearance, and his presence among friends and colleagues as President d'Honneur of the International Orthopaedic Congress to be held in Stockholm next year will be a welcome occasion.

In Sweden, as in every other European country, general surgeons have contributed their quota to the content of modern orthopaedic practice. In this respect Sven Johansson of Gothenburg stands out in bold relief. It is not too much to say that his pioneer work on the internal fixation of fractures of the femoral neck by the canaliculised type of Smith-Petersen pin, introduced over a guide inserted under X-ray control, marked the opening of another epoch in the long history of attempts to treat this fracture by methods applicable to fractures in other parts of the body. His monograph on the *Operative Treatment of Collum Femoris Fractures* (Göteburg 1934) will, in retrospect, take its place amongst our orthopaedic classics. Before leaving the scene of orthopaedics in Sweden we should note the interesting work of Svente Orell in 1932 and later years on the use of os purum and os novum as a substitute for the conventional autogenous bone graft.

In Denmark, with its smaller population scattered throughout a group of islands, two main orthopaedic centres have been developed fully. Both are special institutions on the Swedish pattern, and the treatment of recent fractures for the most part remains the prerogative of the general hospitals. The Copenhagen Orthopaedic Hospital, now housed in a comparatively modern building, owes much of its reputation for sound orthopaedic practice during the last quarter of a century to its surgical chief Poul Guildal and his able team, among whom we may mention Sven Kiaer. The second Danish orthopaedic centre at Aarhus is a more recent development. It has grown steadily in importance and influence under the direction of a man of outstanding personality—P. G. K. Bentzon, one of the best known figures in the International Orthopaedic Society.

In Norway the cause of orthopaedics has been upheld loyally by V. Bulow Hansen (1861–1938) and Eivind Platou, both of Oslo. In the special field of surgical tuberculosis we must also note the name of Halfdan Sundt of Stavern to whose observations on pseudo-coxalgia

we owe much for our understanding of the natural history of this hip joint affection. In Finland, Langenskiöld of Helsinki has been the solitary representative of orthopaedic surgery for many years and has taken an important share in the clinical activities of the Scandinavian Orthopaedic Society.

GERMANY

The contributions of Germany to twentieth century orthopaedic literature have been massive and important but for the most part we have to appraise their significance without more than a glimpse of the personalities behind them, for since 1914 there have been relatively few contacts between British and German orthopaedic surgeons. We have already referred to the authoritarian attempt of the German surgical hierarchy to set a limit to the sphere of action of the orthopaedic surgeons of that country. It must be recognised, however, that some of the most brilliant contributions to the surgery of the locomotor system and its scientific background have come from the German university surgical clinics. The experimental and pathological studies of Axhausen during the period 1908–1928 on bone transplantation, and his work on bone infarction in relation to osteochondritis and chronic arthritis, were of fundamental importance to the practising orthopaedic surgeon. We must also recall the pioneer work of Erich Lexer of Würzburg on the transplantation of joints (1908), of Payr of Leipzig on arthroplasty (1924), and in more recent years the work of Kirschner of Heidelberg on the treatment of fractures.

Among the recognised leaders of pure orthopaedics, in the German sense of that term, we may single out three men for high commendation—Fritz Lange, Konrad Biesalski and Hans von Baeyer. Fritz Lange of Munich was already an outstanding figure in the world of orthopaedics in the earlier years of the century, and he now lives in retirement—a vigorous octogenarian. Despite the German tradition of conservatism in orthopaedics he was an enterprising and bold surgeon. He was probably the first to practise the operation of spinal fusion by the simple technique of wiring together the spinous processes; later he used celluloid plates for this purpose (1910). He led the way in refinements of the technique of tendon transplantation, substituting the method of direct periosteal insertion for the attachment of tendon to tendon; and where tendons were too short to reach their new destinations he prolonged them by silk strands as, for example, in his use of the erector spinae to replace the paralysed gluteal muscles. Lange was a great teacher and he built up a large university orthopaedic clinic in Munich. In 1913 he produced in collaboration with a number of colleagues the standard German text-book of orthopaedics, *Allgemeine Orthopädie und Spezielle Orthopädie* (München 1913), a work which in its own genre can undoubtedly be ranked with the classical text-book of A. H. Tubby.

Konrad Biesalski (1868–1930), trained in the clinic of Hoffa, was an orthopaedic surgeon in the true line of descent from the founders of orthopaedic institutions of the earlier years of the nineteenth century. He believed that orthopaedics was as much a sociological as a surgical vocation. Inspired by this belief, he devoted some six years from 1903 to 1909 to the compilation of a census of crippled children in Germany, and found that there were one hundred thousand such children for whom only three thousand hospital beds were available. He also realised, as did Robert Jones during that same period, that the crippled child had to be educated as well as treated for his physical disability in the same institution. By 1913 the building of the Oscar-Héléne-Heim on the outskirts of Berlin was completed to provide three hundred beds, a school, workshops and research laboratories. This complete orthopaedic institution which supplied all the needs of its child occupants was to be the centre of Biesalski's activities until his death. Among the many additional responsibilities that he shouldered was the editorship-in-chief of the *Zeitschrift für Orthopädische Chirurgie*. Despite his preoccupation with the educational, social and legislative needs of the cripple, Biesalski and his pupils made many valuable contributions to orthopaedic literature. The work by which he will long be remembered is his experimental and clinical study on tendon transplantation

in which Leo Mayer of New York was his collaborator. (*Die physiologische Sehenverpflanzung*, Berlin 1916).

The contributions of Hans von Baeyer (1875–1941), Professor of Orthopaedics at Heidelberg until 1933, on the mechanics of muscular action, clinical kinetics and the biophysical factors concerned in the production of contractures, have perhaps not received the wide publicity that is merited by their importance. Von Baeyer's studies were more than academic exercises: they illuminated many of the difficult mechanical problems which crippling diseases continued to present to the orthopaedic surgeon. It should be remembered also that von Baeyer devised the bifurcation osteotomy for congenital hip dislocation (1918); and that *translocation* of tendons was another of his ingenious ideas—for example, translocation of the flexor pollicis longus in paralysis of the thenar muscles.

We have selected three surgeons only as profiles to illustrate the story of twentieth century German orthopaedics. There are others whose distinguished labours must not be overlooked: Schanz of Dresden (1870–1932), a resourceful surgeon and known for his subtrochanteric osteotomy; Oscar Vulpius of Heidelberg, an early exponent of tendon transplantation; Peter Bade of Hanover; Stoffel of Mannheim (1880–1937) who devised the operation of neurotomy for spastic palsy; Schede of Dresden who prepared the German report on the results of treatment of congenital dislocation of the hip joint for the ill-fated International Congress of 1939; Hermann Gocht (1869–1938), pupil of Hoffa, later occupant of the chair of orthopaedics in the University of Berlin, and president-elect for the 1939 congress of the International Orthopaedic Society. The doyen of German orthopaedics to-day is Georg Hohmann, the successor of Lange in the university chair in Munich, who since the war has occupied the distinguished office of Rector of the University. Hohmann's many contributions to orthopaedic literature have been confined to problems mainly drawn from the older orthopaedics and a new edition of his well-known monograph, *Fuss und Bein* (München 1948) has recently appeared.

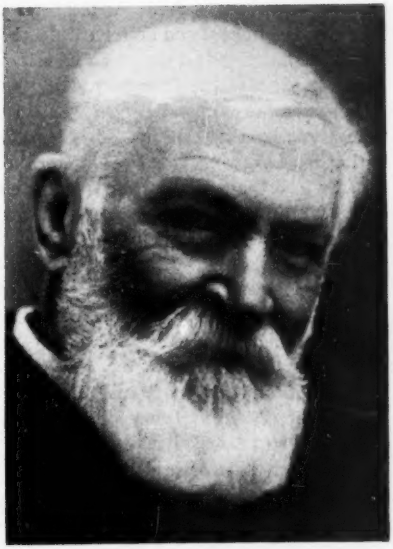
AUSTRIA

Adolf Lorenz (1854–1946) was a dominating figure in European orthopaedics during the closing years of the nineteenth century and by then he had standardised his manipulative technique for the bloodless reduction of congenital dislocation of the hip. It was not until 1904 that he began to travel to other countries to demonstrate his method to surgical audiences who were eager to see the master at work. In the catastrophic financial collapse of Austria which followed the first world war Lorenz lost his life savings overnight, but during the next decade he repaired his fortunes in a series of visits to the United States. His tenure of the professorship of orthopaedics in Vienna had then come to an end under the age limit and his creative work lay behind him in the past. His one remaining contribution was to popularise the operation of bifurcation osteotomy (1919). It was not his own idea, for von Baeyer had already worked out its mechanical basis, and the chief credit for the more discriminating application of this procedure to different types of hip joint affection must be given to his pupil, Julius Haas, who followed him in the university chair and filled it with distinction until he was forced out by the Anschluss. Lorenz has told his own story, and it is part of the history of European orthopaedics, in his autobiography written in vivacious fashion at the age of eighty-two (Scribners, New York 1936). He made of orthopaedics a spectacular art and his place is secure in our gallery of heroes.

The concentration of military orthopaedic activities in the capital of the Austro-Hungarian Empire during the first world war by which to provide for the growing numbers of amputees, and for other severely crippled men in need of physical rehabilitation, brought Hans Spitzy to Vienna from Graz where he had held the chair of children's surgery and orthopaedics (in the French fashion) and had made a notable contribution to Lange's text-book. In Vienna, Spitzy took charge of a large war-time hospital and began to devote special attention to the operative treatment of peripheral nerve injuries. It was a field of surgery for which he had a

FRITZ LANGE

PATRICK HAGLUND (1870–1937)



ADOLF LORENZ (1854–1946)

natural bent, for he had been engaged for some time in testing the value of anastomosis between selected motor branches of the large nerve trunks in the hemiplegic upper limb. After the war Spitzy settled in Vienna and his hospital was ultimately converted into a civilian orthopaedic institution. It seemed likely at one time that Spitzy's clinic would become a popular post-graduate school of orthopaedics, but the rise of the Bologna school and the arrival of Lorenz Böhler in Vienna soon offered more exciting prospects to the young surgical traveller.

Lorenz Böhler's impact on the field of fracture surgery has been one of the dynamic events of twentieth century orthopaedics. Böhler began his medical life as a country doctor and general practitioner-surgeon. During the first world war he took charge of a military hospital at Bozen where he treated a large series of gun-shot fractures of the femur. In 1925 he was called to Vienna to organise the Accident Hospital founded and maintained by the Austrian National Insurance Company. His revival of the Lucas-Championniére-Delbet practice of early weight-bearing in lower limb fractures, his use of unpadded plaster splints and casts and the organisation of active rehabilitation programmes without the aid of apparatus, soon began to attract postgraduates from far and wide. Böhler's major contributions to fracture surgery in monograph form are of course familiar to orthopaedic surgeons throughout the world (1929, 1930, 1932). It is interesting to trace in successive editions the guiding principles to which he always held fast during the various stages of trial and error, and the ultimate simplification of technique in the handling of certain special types of fracture. Since the war Böhler has become an enthusiastic exponent of the Küntscher method of internal fixation of fractures by intramedullary nailing (1949). The Vienna experiment, as it may be called, has proved that within the framework of comprehensive orthopaedic schemes there is a place for the accident hospital.

SWITZERLAND

The development of Swiss orthopaedics has been based on the traditional pattern of orthopaedic institutes in the main centres providing for the surgical, re-educational and social needs of the crippled and deformed. Mechano-therapy has always been a feature of the Swiss orthopaedic clinics—no doubt an inheritance from the teaching and practice of Schultess of Zürich in the nineteenth century. Among the special institutes which to-day represent Swiss orthopaedics we may single out the Anstalt Balgrist in Zürich which has been directed for more than a quarter of a century by Richard Scherb who is to be president of the International Orthopaedic Congress next year in Stockholm. Scherb has also gained the unusual distinction for a Swiss orthopaedic surgeon of being elected to a professorial chair in his subject. He has devoted much time to the analysis of muscle action in paralysis with the aid of apparatus devised for this purpose.

Acute orthopaedics has remained under the wing of the great University surgical clinics at Berne, Lausanne, Zürich and Basel. In the latter centre we must pay tribute to the researches of Henschen on the physical properties of bone which have led to a better understanding of the behaviour of skeletal tissue under stress (1932–1937). Among other noteworthy contributions from general surgeons in Switzerland we may recall that Bircher was one of the early continental surgeons to deal with the problem of internal derangement of the knee (1925); and that Steinmann who also wrote on this subject in 1926 was a pioneer in the technique of skeletal traction.

Between the two world wars no "grand tour" of European orthopaedic clinics was complete without a visit to Leysin to see the work of that remarkable man Rollier. At the height of his activities Rollier was neither a general surgeon nor an orthopaedic surgeon in the narrowest sense of these terms. He treated surgical tuberculosis by rest and controlled helio-therapy, and in bone and joint tuberculosis used a minimal amount of mechanical restraint for the affected area. Rollier also radiated an atmosphere of cure—a vital attribute in dealing with

patients who had to face long periods of relative immobility. His interest in the welfare of the victims of surgical tuberculosis extended to their rehabilitation after active treatment had been concluded, and the establishment under his guidance of what he called " factories in the sun " was a notable contribution to social orthopaedics.

SPAIN AND PORTUGAL

In the countries of the Iberian Peninsula, orthopaedics appears to have developed in conformity with the usual mixed patterns. San Ricart of Barcelona has been a familiar figure at national and international congresses during the last twenty-five years despite the political upheavals in Spain, and by his qualities of mind and heart he has shown himself to be first and foremost a " good European." He has for many years made a special study of amputations and of the problems relating to prostheses.

Bastos y Ansart, who at one time in Madrid directed a large rehabilitation hospital providing for the needs of soldiers wounded in the Spanish adventures in Morocco, has now settled in Barcelona. In earlier years many of his contributions were concerned with the general field of orthopaedics but latterly his interests have been directed towards traumatology.

It is fitting here to record that from the Catalan capital British orthopaedics has acquired one of its brightest ornaments in the person of Joseph Trueta, now of Oxford.

MIDDLE EUROPE AND RUSSIA

In the period of our review, orthopaedics in Hungary, though to some extent overshadowed by the dominating influence of the Vienna school, was represented worthily by men such as Michael Horvath (1868–1938) who directed the first complete orthopaedic institute at Budapest, and Eugene Kopits (1869–1946) who combined orthopaedics with children's surgery and was the founder of the Hungarian Orthopaedic Society and author of the first treatise on orthopaedics in the Hungarian language. We are also indebted to Hungary for one of the most important contributions in recent times on the pathogenesis of scoliosis by A. Farkas, *Uber Bedingungen und auslosend Momente bei der Skoliosenentstehung* (Stuttgart 1925).

In the university cities of the old Czechoslovakia, orthopaedic clinics developed in accordance with the contemporary German and Austrian patterns; but during the independent life of the Czechoslovakian republic French influences also played their part. Among the leaders of modern European orthopaedics Jan Zahradnicek of Prague has for some years held a high place. His work on the treatment of congenital dislocation of the hip in infants, and on the technique of open reduction in older children, had a marked influence on Jacques Leveuf's approach to these problems as the latter acknowledged so freely.

For many obvious reasons it is difficult to appraise the contributions to twentieth century orthopaedics of Poland, Yugoslavia, Roumania, Greece and Turkey but tribute must here be paid to such men as Adam Gruca of Warsaw and Dimitrijie Yovtcitch of Belgrade who in face of formidable obstacles to travel have shown by their loyalty to the International Orthopaedic Society how much they value membership in the comity of European orthopaedic surgeons.

For a long time we have looked at Russian orthopaedics " through a glass darkly " but we have been able to perceive clear outlines of the figure of one man—Henry Turner of Leningrad. Before the revolution of 1917, Turner had been professor of orthopaedics in the Imperial Military Academy of Medicine and he was allowed to retain this post under the Soviet Government for many years. Turner attended the International Congress of Medicine in London in 1913 and was one of that distinguished gathering of orthopaedic surgeons from many nations who were entertained to dinner by Robert Jones on a memorable evening at the Royal Automobile Club. For some years after the first world war Turner corresponded regularly with Sir Robert who was able to arrange for the publication of a number of his articles in British and American journals. His completion of fifty years of active work in

orthopaedic surgery was recognised by the Soviet Government as a notable contribution to human welfare and it was commemorated, as in any capitalist country, by the presentation of his portrait painted by a leading Soviet artist! In this picture the great surgeon appears not in formal dress, nor even gowned for the operating theatre; but armed with hammer he stands in shirt sleeves before an anvil. In the background we get a glimpse of a workshop and of the orthopaedic appliances he symbolically forged; but there is also another human figure—a crippled boy.

REFERENCES

BAEYER, H. VON (1933): Société internationale de Chirurgie Orthopédique. Deuxième Congrès. Bruxelles: Imprimerie Lielens.

CALVÉ, J., and GALLAND, M. (1930): Physiologie Pathologique du Mal de Pott. Revue d'Orthopédie, **17, 5**.

GALEAZZI, R. (1927): Journal of Bone and Joint Surgery, **9, 515**.

JANSEN, M. (1920): On Bone Formation: Its Relation to Tension and Pressure. Manchester: University Press. London: Longmans Green & Co.

LERICHE, R. (1939): Physiologie et Pathologie du Tissu Osseux. Paris: Masson et Cie.

LEVEUF, J. (1936): Le syndrome de Volkmann. Revue d'Orthopédie, **23, 5**.

LEVEUF, J. (1947): Les Lésions Initiales de L'Ostéomyelite Aiguë. Revue d'Orthopédie, **33,** 177.

LEVEUF, J., and BERTRAND, P. (1946): Luxations et Subluxations congénitales de la Hanche. Paris: Doin et Cie.

SORREL, E. (1921–1939): Publications sur la Chirurgie Osseuse. Paris.

SORREL-DÉJERINE, Y. (1926): Contribution a l'étude des paraplégies pottiques. Paris: Masson et Cie.

FIFTY YEARS OF ORTHOPAEDIC SURGERY IN CANADA

R. I. Harris, Toronto
W. E. Gallie, Toronto
A. McLachlin, London, Ontario
J. A. Nutter, Montreal
T. B. Acker, Halifax, N.S.
A. Gibson, Winnipeg
F. H. H. Mewburn, Edmonton
J. P. Patterson, Vancouver

Canada is a country so vast that the development of orthopaedic surgery has not followed the same uniform plan as in smaller and more compact countries. The university centres of Toronto and Montreal have gained inspiration from England and stimulus from the United States; London and Kingston, Ontario, are competing with Toronto; Montreal, the second largest " French " city in the world, shares with Quebec its inspiration from France; Winnipeg still represents the Middle-West with its staunch adherence to " the old country "; Edmonton in Alberta has one of the richest as well as the youngest of medical schools; Vancouver in British Columbia has recently appointed its first professor of surgery; and Newfoundland and the Maritime Provinces have been influenced no less by New England than by England. In this great country, with its multiplicity of influences, the development of orthopaedic surgery can be considered best on a regional basis.

ORTHOPAEDIC SURGERY IN TORONTO

In Toronto, as in many other centres, orthopaedic surgery had its beginnings in a special interest taken by certain general surgeons in the deformities and deforming diseases of childhood. Before 1900 all cases now grouped as orthopaedic were treated by the general surgical staff, much as were the cases now segregated as thoracic, neurosurgical, vascular, urological, plastic and so on. From that time on, however, certain general surgeons began to take interest in special fields and laid the foundations for the development of various surgical specialities. Orthopaedic surgery was one of these and its founder in Toronto was Clarence Leslie Starr.

Under Starr's leadership there developed at the Hospital for Sick Children a school of orthopaedic surgery which quickly took a leading place in Canada and indeed in the whole of America; the group worked together in the greatest harmony for many years, both in peace-time and in war, always stimulating and helping one another, and always striving to advance scientific knowledge and enhance the reputation of their school. Death and retirement alone interfered with this delightful association, and even then the gaps were ably filled.

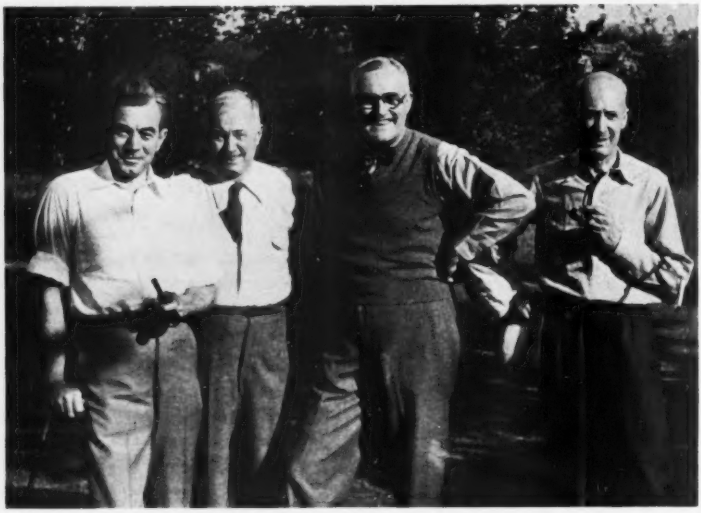
In early days, before the first world war, the field was not wide and did not merit segregation. However, with the tremendous advance that occurred during the war, adding as it did all sorts of lesions of bones, joints, nerves and the deformities resulting therefrom, and many of the problems now dealt with by plastic surgeons, the necessity for specialisation became very evident and soon was in full process of development. The speciality is still broadening and is now encroaching on the field of trauma.

Looking back over the years it is interesting to recall some of the special studies that engaged the attention of these men. In the early days at the Children's Hospital a large proportion of the patients suffered from tuberculosis of bones and joints. Starr's chief interest for many years was the prevention of secondary infection in tuberculous abscesses. In this he tried Lister's method of incision and drainage with infrequent antiseptic dressings; then aspiration and injection with iodoform emulsion; and finally, after a visit to Barker at University College Hospital, London, incision, evacuation, curettage and closure. While

these efforts were not always successful there was, nevertheless, a striking reduction in the secondary infections. No further progress was made in this direction until antibiotics were discovered. An interesting study was then instituted by Coulthard at the Toronto Hospital for Consumptives, under the guidance of R. I. Harris; and great progress was made.

A problem that always interested Starr was osteomyelitis and he published several papers which guided most Canadian and American surgeons for many years. His chief dictum was " early and adequate drainage without increasing the necrosis." With the discovery of the sulfonamides and later, penicillin, a concerted attack was again made on this disease under the leadership of D. E. Robertson and F. R. Wilkinson, and their papers were among the earliest to record the marvellous influence of these drugs.

Early in the century several epidemics of poliomyelitis in Ontario left a broad trail marked by great numbers of crippled children. These cases enabled the young orthopaedic surgeons to try out the possibility of converting the tendons of paralysed muscles into



R. I. Harris, D. E. Robertson, W. E. Gallie, A. B. Le Mesurier.

ligaments and develop an operation called " tendon fixation." Several papers came from the pen of W. E. Gallie and for a time it was hoped that an important contribution had been made. The passage of years unfortunately showed that the results of the operation were uncertain and often impermanent, and it has been largely replaced by other methods.

About 1911 great interest arose in the transplantation of bone. Many of the principles had been laid down by Macewen, Ollier and Axhausen, but it remained for Albee to demonstrate the great practical value of the idea and to develop a simple technique. Recognising that this was perhaps the most important contribution that was likely to be made to the surgery of bone for a long time, Gallie and Robertson undertook a series of experiments on animals in order to test previous statements and, if possible, to add something to the sum of knowledge on the subject. This study, leading to a series of papers, the last of which was published in the British Journal of Surgery in 1919, formed the basis of teaching of the surgery of bone in the Toronto school.

The war of 1914–18 was perhaps the strongest influence in establishing orthopaedic

surgery as a speciality in Canada. Not only did it provide the opportunity to test newly acquired knowledge of the surgery of bone, but it opened whole new fields in the surgery of tendons, ligaments, nerves and muscles. It certainly broadened the field sufficiently to attract men who otherwise would have continued in general surgery. Among the problems presented was that of amputations. Early in 1915, largely on the advice of Professor Starr, the Government adopted a policy of establishing its own artificial-limb factory and supervising the subsequent medical care of amputees. This gave A. B. Le Mesurier and Gordon Dale, who were made surgical consultants on amputations and artificial limbs, the opportunity to observe thousands of amputation cases and, figuratively, to watch them march down the years.

Hospital for Sick Children, Toronto. Architect's original drawing of the old building now being replaced. The corner-stone of this building was laid in September 1889.

This opportunity led them to the very definite opinion (which has been called the " Canadian opinion ") that end-bearing stumps from Syme and Gritti-Stokes operations had great merit. Their influence accounts largely for the popularity of these operations in America.

The concentration of all cases of surgical tuberculosis in the Veterans' Hospital in Toronto gave R. I. Harris the opportunity to make an extensive study of the relationship of tuberculosis in bone to tuberculosis in the urinary and genital tracts. His paper " Tuberculous Bacilluria," published in the *British Journal of Surgery* in January 1929, attracted marked attention.

The most important contribution made by Bruce Robertson during his short life was not connected exclusively with orthopaedic surgery but was equally important in all forms of surgery complicated by haemorrhage and shock. Early in his career he became interested

in the newly discovered technique of blood transfusion. When the Canadian army went to France he performed the first blood transfusion ever done in battle. His work with No. 2 Canadian Casualty Clearing Station at Remy Siding was observed by the British consultants, Gordon-Taylor, W. Anderson and John Fraser, and led to the widespread use of this method in the British Army. Robertson later developed the method known as "exsanguination transfusion" in an attempt to get rid of the toxaemia of burns; it was of course not the answer to the problem but the method still exists in the treatment of new-born infants with a defective rhesus factor.

Attracted by the demonstration of Kirschner that fascia lata could be transplanted to another place in the same animal and survive, Gallie and Le Mesurier carried out a long series of experiments on animals which led to the "living suture" operation for hernia and the repair of various injuries of ligaments. A series of papers was published, the last of which formed the basis of a Hunterian Lecture delivered at the Royal College of Surgeons in 1924. Since then the principle has been applied in the treatment of recurring dislocation of the shoulder, and a series of two hundred operations was reported in a Moynihan lecture in 1947.

The visit of Royle and Hunter to Canada in 1925 aroused great interest among the staff of the Children's Hospital in the possibilities of sympathetic ramisection and ganglionectomy in infantile paralysis. The two Robertsons, R. I. Harris and J. L. McDonald explored the field thoroughly; Harris ultimately demonstrated that ganglionectomy on the paralysed side not only retarded shortening but in some cases actually lessened the shortening already present. This observation has not received the attention it deserves, but has recently been commented on favourably by Barr of Boston.

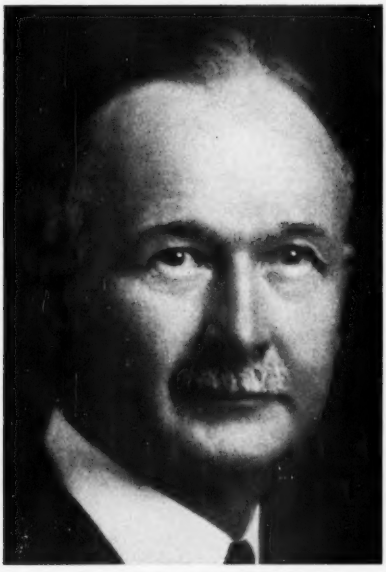
In the absence of clear limitations of the field of orthopaedic surgery, overlapping has naturally occurred. Thus, Le Mesurier has taken great interest in the treatment of harelip and cleft palate, and his papers have standardised the treatment of this deformity. Again, the researches of A. W. Farmer, involving the interest of both the orthopaedic and the plastic surgeon, have been directed to the repair of tendons and their sheaths. His suggestion, too, that skin avulsed in accidents could be cleansed, freed of subcutaneous tissue and used as a whole-thickness graft has had wide acceptance.

Stimulated by the physiological studies of Professor Charles Best on "heparin," Gordon Murray undertook an exhaustive series of experiments on animals, and later on patients, which established the importance of anticoagulants in the prevention of venous thrombosis and pulmonary embolism. These studies were reported in a Hunterian Lecture in 1939 and have not only been of value to the orthopaedic and general surgeon but have led to great widening of the field of vascular surgery.

R. I. Harris's Hunterian Lecture in 1949 on spondylolisthesis was a masterly review. Based on a huge clinical experience and careful study of all his cases he has evolved a technique in treatment which appears to be infallible. That the honorary fellowship of the Royal College of Surgeons of England was conferred upon him at the time of this lecture was widely appreciated by Canadians.

The close relationship between orthopaedic and traumatic surgery has always interested the Toronto group of surgeons. Papers by Gordon Murray on bone grafting in non-union in fractures of the carpal scaphoid, on intramedullary wiring in fractures of the clavicle and other bones, and on external pin fixation in badly comminuted Colles fractures have aroused favourable comment. Other papers by Harris on reduction of fractures of the os calcis, by Gallie and Lewis on non-union in fractures of the neck of the femur in the aged, by Gallie, White and Charles Harris on arthrodesis in the subastragalar and ankle joints, and by McDonald on fractures of the elbow have had their place. The contribution of J. L. McDonald towards bettering the treatment of fractures under the Workmen's Compensation Board was outstanding.

The gradual delineation of orthopaedic surgery as a speciality has had its effect on the



CLARENCE LESLIE STARR (1867–1920).

FREDERICK G. BANTING (1891–1941).

[*Photograph by the* Telegram, *Toronto.*]

DAVID EDWARD ROBERTSON (1884–1944).

L. BRUCE ROBERTSON (1885–1923).

staff organisation of the Toronto hospitals. Whereas twenty-five years ago no special orthopaedic services were recognised, now almost all hospitals have such services. At the General Hospital a large and very active division has been organised under the direction of R. I. Harris, assisted by F. P. Dewar and D. McIntosh. At St. Michael's, the Western, the East General and St. Joseph's hospitals a beginning has been made in establishing similar services under the direction respectively of Paul McGoey, A. W. M. White, Leslie Black and H. M. Coleman, and George Pennel. In the university hospitals these orthopaedic services share in undergraduate teaching and in the graduate-training of general surgeons. By an arrangement between the General and the Children's Hospitals a residency system has been established which offers adequate training for specialists.

During and after both wars the Toronto group made important contributions to the welfare of our troops. In the war of 1914–18 Colonel C. L. Starr organised and led into successful operation the Canadian Orthopaedic Service overseas and subsequently—as Consultant to the Director-General of Medical Services and the Department of Veterans' Affairs—an efficient nation-wide service. Outstanding were the organisation and operation of

[*Photograph by the* Telegram, *Toronto.*]
Rescue of D. E. Robertson from Moose River mine, April 23, 1936.

government amputation clinics and an artificial-limb factory, which have stood the test of thirty years. In the recent war the leadership devolved upon Colonel R. I. Harris whose position as Consultant to the Director-General of Medical Services enabled him to ensure efficient organisation and to conduct important research. Outstanding in this was a study of foot defects in soldiers, which was based on a detailed study of the feet of four thousand men. It led to a monumental report by Harris and Beath which will undoubtedly standardise opinion and practice in regard to the feet of soldiers.

A peace-time activity which has interested this group has been the establishment and management of clinics for crippled children all over the Province of Ontario. At suitable intervals a team of orthopaedic surgeons goes out to the various towns and cities, sometimes as far as five hundred miles, and with the aid of the Ontario Society for Crippled Children and one of the Service Clubs, rounds up between one and two hundred out-patients and gives advice on treatment. Those requiring special hospital care are sent to one of the established children's or orthopaedic hospitals. In this way the benefits of scientific medicine are brought to districts where no specialist services exist.

The passage of the years has brought international recognition and many honours to the group. Five have been presidents of the American Orthopaedic Association, three have been

Hunterian Professors in the Royal College of Surgeons of England, one was made an honorary Fellow and one was a recipient of the honorary medal of the College.

Aside from the excitements and triumphs of two great wars the most thrilling moment in the lives of two senior members of the group came at midnight on April 23, 1936, when D. E. Robertson was brought out alive from the Moose River Gold Mine disaster. Eleven days' incarceration in that black hole, with hardly a hope of rescue, completely failed to daunt his spirit; and he was to live for many years as the distinguished head of the Department of Surgery at the Children's Hospital. A photograph on the preceding page shows the hero of the occasion being welcomed back to this life by Gallie and a great throng of onlookers, well-wishers and friends.

Delightful associations have been made with both the British and the Americans which were immensely strengthened in 1948 during the combined meeting in Quebec under the presidencies of Malkin and Harris. Such intimate contacts remind us that the isolation of former years is over and that we must be prepared to take an increasingly important part in the deliberations of orthopaedic surgeons wherever our language is spoken. The preparation of this account of the orthopaedic surgery of Toronto has given vivid and happy recollections to the writer, who is now retired, and has made him reflect on his good fortune in being associated with so charming and gifted a group of men.

WESTERN ONTARIO

The history of orthopaedic surgery in Western Ontario is confined almost entirely to this century. Dr B. E. MacKenzie of the Orthopaedic Hospital in Toronto began to pay regular visits to the area about the year 1900; and Dr Stewart Wright, one of MacKenzie's pupils and a member of the staff of the Western Hospital in Toronto, continued this work. Another general surgeon with a special interest in orthopaedics was Dr Hadley Williams. Born in England in 1864, he graduated from the University of Western Ontario in 1888. After training in England and acquiring the English Fellowship he returned to the University of Western Ontario as Professor of Surgery in 1909 and continued in this position until his death in 1932.

It is of interest that Frederick Banting, who later became famous for his work on insulin, was the first surgeon to limit his practice to orthopaedics in Western Ontario. After working in the hospital for Sick Children in Toronto he came to London, Ontario, in 1920 to practise orthopaedic surgery and teach in the department of physiology of the medical school of the University of Western Ontario. He remained only a year before he returned to Toronto with the idea that led to his great discovery. His reception in London had been disappointing, but it is recorded that he was the first to administer blood transfusions to children in Western Ontario, following the teaching of Bruce Robertson of the Hospital for Sick Children in Toronto.

The War Memorial Children's Hospital in London was opened in 1922. The late Dr George Ramsay was prominent in its development from the outset. After obtaining surgical training in the Presbyterian Hospital in Chicago in 1913, he had served overseas in the first world war and spent some time with Sir Robert Jones in Liverpool after the war. He was keenly interested in the Children's Hospital and began gradually to confine his practice to orthopaedic work. When the Ontario Society for Crippled Children was founded in 1922 he became the bulwark of the organisation in Western Ontario. He established orthopaedic clinics in Sarnia and Seaforth as well as in London, and made contacts with the Service clubs in the area that were of great service in obtaining orthopaedic help for the people of Western Ontario—particularly for indigents and patients in outlying areas. The recent addition to the War Memorial Children's Hospital in London is largely the result of his efforts.

In Windsor, Dr Brockenshire has played the leading role in orthopaedic surgery. After completing his training in Edinburgh in 1932 he returned to Windsor and confined himself to the practice of orthopaedics. His influence has been felt very widely in the western part of Western Ontario.

ORTHOPAEDIC SURGERY IN MONTREAL

About twenty years ago there were some eight to ten surgeons in Montreal who confined their practice to orthopaedic surgery alone. It was felt that we orthopaedic surgeons ought to get together and know each other better: a meeting was called in the surgical amphitheatre of the Montreal General Hospital and was attended by Doctors Nutter, Turner, Forbes, Patterson, Derome, Caisse, Williamson, Breitman and Goldman. A quadriceps lengthening operation was done by Dr Nutter assisted, if memory serves, by Goldman. That was the beginning of the Montreal Orthopaedic Association, which is still going strong after so many years. We met once a month at various hospitals during the winter and spring. We read papers, showed cases and discussed them. We kept no minutes then—we just grew. The association attracted orthopaedic surgeons and others interested in orthopaedic surgery from other cities—particularly from Ottawa and Quebec. It was always bilingual.

Dr J. Edouard Samson was one who was impressed by the success of the association and he went a step further—he suggested the foundation of a Canadian Orthopaedic Association.

A group taken in 1939. *Standing, left to right:* Drs U. Frenette, A Couturier, S. E. Goldman, Mr J. A. Duckett, Dr J. G. Shannon, a visitor, Dr Gordon Petrie. *Sitting, left to right:* Drs G. Caisse, W. G. Turner, Rupert Derome, W. J. Patterson, J. A. Nutter and N. T. Williamson.

After much discussion, and with some misgivings which have proved unfounded, his suggestion was accepted and the national association was founded in 1945 with J. A. Nutter as its first president. It prospered from the beginning; meetings have been held annually under the successive presidencies of J. A. Nutter, Edouard Samson, R. I. Harris and Alexander Gibson. Dr J. A. Leo Walker has been the very active secretary of the association and his services are invaluable.

In 1943 the Royal College of Physicians and Surgeons of Canada undertook the certification of specialists and the writer was asked to represent the speciality of orthopaedic surgery. No one was to be barred from practising orthopaedics, but only the holder of a certificate from the Royal College could be regarded as a specialist. The first register included some forty-four names.

The doyen of orthopaedic surgeons in Montreal is undoubtedly W. G. Turner, a member of an old Quebec family, who graduated in arts at McGill University in 1896 and in Medicine

[*Photograph by William Notman & Son Ltd.*]

A. MACKENZIE FORBES (1874–1929).

J. EDOUARD SAMSON.

[*Photograph by Nakash.*]

J. A. NUTTER.

in 1900. He interned at the Montreal General Hospital, and later became medical superintendent. From this post he took a position at the Royal Victoria Hospital as surgeon in charge of orthopaedics in the department of general surgery. He was also clinical professor of orthopaedic surgery at McGill, and head of the Shriners' Hospital. He retired a few years ago in favour of Dr Gordon Petrie. Another of the " old-timers " in Montreal was the late Archibald MacKenzie Forbes, who practised orthopaedic surgery at the Montreal General Hospital and the Children's Memorial Hospital. The orthopaedic clinics were small in those days—speaking now of 1911—and there were seldom more than five or six patients thrice weekly. Forbes was a dramatic teacher. One of his favourite subjects was the differential diagnosis between acute rheumatic fever and acute osteomyelitis near the knee. In later years he was president of the American Orthopaedic Association; among his contributions was an operation for spinal fusion. With his forceful personality he was able to enlist the financial support of the late Lord Atholstan, of the Montreal *Star*, in founding the Children's Memorial Hospital; it was opened in 1909 in memory of Queen Victoria. Forbes had a full and bounding pulse, of which he was very proud: but it was, in reality, evidence of heart disease which was the cause of his untimely death in 1929. He was succeeded at the Children's Memorial Hospital by Norman T. Williamson, who later became chief of the orthopaedic department at the Montreal General Hospital. He died in 1947 at the age of fifty-four.

Montreal Sacred Heart Hospital.

Dr J. Edouard Samson came to Montreal in 1930, bringing Dr Ulric Frenette, his partner and right-hand man, with him. Samson had graduated from Laval University in Quebec and had studied with Hibbs and Albee in New York, and with Nové-Josserand in Lyons. He now directs a unit of 200 beds at the Sacré Coeur Hospital at Certierville. He is said to have the largest series of cases of arthroplasty of the knee in existence.

Among the prominent younger men in Montreal are Dr James G. Shannon, now chief of the orthopaedic department at the Montreal General Hospital; Dr S. E. Goldman of the Montreal General, Women's General and Jewish General Hospitals; Dr J. C. A. Marchand, who has recently been appointed Lecturer in Orthopaedic Surgery at the University of Ottawa; and Dr Calixte Favreau, Professor of Orthopaedic Surgery at the University of Montreal since 1944.

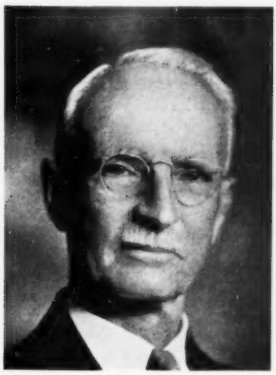
ORTHOPAEDIC SURGERY IN WESTERN CANADA

In this part of Canada the pioneer of specialism in orthopaedic surgery was H. P. H. Galloway. He was born in 1886 and after assisting McKenzie in Toronto came to Winnipeg in 1905. Two years later he obtained official recognition in the speciality by being appointed lecturer in orthopaedic surgery in the medical school, while in the same year he was appointed to the staff of Winnipeg General Hospital as orthopaedic surgeon. Galloway continued in practice until his death in 1939 at the age of seventy-three. In 1919 he was President of the American Orthopaedic Association. He was a tireless worker and a resourceful and skilful

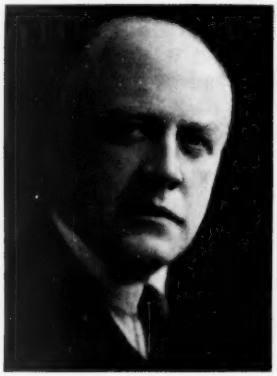
operator. Many contributions from his pen illustrated his thoughtful outlook; the most notable of these was his bold affirmation in 1920 that congenital dislocation of the hip joint in children promised better results if submitted to open operation than if treated by closed reduction.

Since these early days an increasing number of men have devoted themselves to orthopaedic work. In the city of Winnipeg alone there are fifteen such specialists, and in every large centre of population throughout Western Canada the story is similar. Regina, Saskatoon, Calgary, Edmonton, Vancouver and Victoria, all are served admirably by young and vigorous, well-trained men, contributing to the progress of the art and banded in associations of urban, provincial and national scope. Both in Winnipeg and Vancouver very close relationship is maintained with the adjoining sections of the United States.

In Winnipeg, as in other cities, hospital facilities are hardly adequate for the needs. Besides beds in the Winnipeg General, St. Boniface and the Children's Hospitals, there is a new Shriners' Hospital of forty beds opened in 1949. At the Veterans' Hospital, Deer Lodge, there is a staff of five visiting orthopaedic surgeons each of whom is engaged in clinical or



H. P. H. Galloway.



Peter A. McLennan.

Frank P. Patterson.

experimental research as well as the practice of orthopaedics. The use of the fish-tail or clothes-pin graft for spinal fusion described in 1931, and the routine adoption of the "posterior" approach to the hip joint have been strongly advocated from Winnipeg. Tuberculosis of the bones and joints is still a matter of some consequence among the Indians who are cared for in sanitoria at Brandon and St. Boniface. In 1939 a fracture service was established in Winnipeg General Hospital on the lines of the Manchester fracture clinic. During the ten years since its inception some fifteen hundred cases have received treatment.

The majority of the men practising orthopaedics in Western Canada are still on the sunny side of forty-five. Most of them are Fellows of the Royal College of Surgeons of England or of Canada; in Winnipeg alone, three have obtained the Liverpool degree of Master of Orthopaedic Surgery. Throughout the whole of Western Canada the craft of orthopaedic surgery is in able, youthful and energetic hands.

BRITISH COLUMBIA

The history of orthopaedic surgery in British Columbia is short—so, indeed, is the history of medicine in this Province. At the beginning of the century there were two hundred doctors engaged in general practice and one specialist in diseases of the eye, ear, nose and throat. It was from this group of general practitioners that came the pioneers of traumatic and

orthopaedic surgery. Two names stand out among them—Dr Peter A. McLennan and Dr Frank P. Patterson.

McLennan graduated from McGill University in 1898, began practice at Nelson in 1899 and moved to Vancouver in 1905. He gained a wide reputation in surgery throughout the province. His name is closely linked with the development of the Vancouver General Hospital, whose staff he joined in 1912. When the hospital was reorganised in 1930 he became the first chief surgeon and continued in this post until his retirement. He was responsible for developing a fracture service which, though at first a part of the general surgical service, later came under the direction of the orthopaedic service. Fondly known as " Big Pete," Dr McLennan is still engaged in practice in Vancouver. He is a raconteur of great skill, and the historian and " elder statesman " of medicine in British Columbia.

Frank Patterson, a graduate of McGill in 1898, was the first in British Columbia to confine his work to orthopaedic surgery. He began practice in New Brunswick but moved to British Columbia in 1902, where he practised in Trail until 1908. Subsequently he studied in Britain, took the Fellowship of the Royal College of Surgeons of Edinburgh in 1909 and returned to general practice in Vancouver. After serving in the Canadian Army during the first world war he spent a year with Dr C. L. Starr at the Christie Street Hospital in Toronto, and returned to Vancouver in 1919 to confine his work to orthopaedic surgery. He became the first chief of the orthopaedic service in the Vancouver General and St Paul's Hospitals. He retired from the former in 1936, to be succeeded by the present chief, Dr J. R. Naden. Patterson died in 1938 at the age of sixty-two and was succeeded at St Paul's Hospital by D. Murray Meekison.

Those who followed McLennan and Patterson are all of a different generation and all except Meekison, who died in 1945, are still engaged in practice. At the present time there are fourteen orthopaedic surgeons in the Province; and the senior, Dr J. R. Naden, is still under fifty years of age. This is indicative of the short history of orthopaedics in British Columbia.

THE MARITIME PROVINCES AND NEWFOUNDLAND

The development of orthopaedic surgery as a speciality in the Maritime Provinces followed the first world war. Three medical officers from Nova Scotia availed themselves of the opportunity arranged by Sir Robert Jones to pursue postgraduate training at orthopaedic centres in England before returning to Canada for demobilisation. Two of these, O. G. Donovan and J. N. Lyons, returned to Halifax. Donovan held an appointment at Camp Hill, a hospital of the Department of Veterans' Affairs, and later became chief medical officer of the Nova Scotia Workmen's Compensation Board. Ross Miller returned to Amherst, Nova Scotia, where he carried on general practice with a leaning towards orthopaedics, and later became Director of Medical Services for the Department of Veterans' Affairs—an appointment which he held during World War II.

When the Canadian Medical Association held a meeting in Halifax in 1921, MacAusland of Boston presented a paper on his arthroplasty of the elbow joint. A young graduate from Dalhousie University, assisting the local committee on exhibits, met Dr MacAusland who became interested in him and not only suggested that he should pursue the speciality of orthopaedic surgery but offered an appointment on one of his hospital services in Boston. He pointed out that in his own practice many patients came from the Maritime Provinces and that there should be an excellent opening there for one who specialised in orthopaedics. He felt that someone should come back to Halifax, a university centre, properly trained in this speciality. The young graduate in medicine (who is the writer of this account) went to Boston to the MacAusland Clinic in September 1921. The work was interesting and fascinating; after working in the Crippled Children's clinics all over New England and spending six months in New York with Whitman and Hibbs he returned to Halifax in July 1923, opened an office and confined his practice to the speciality of orthopaedic surgery.

In July 1924, Dalhousie University Health Centre opened an orthopaedic clinic staffed by J. N. Lyons and Tom B. Acker. This was the first teaching appointment in orthopaedics at Dalhousie University. In the same year Tom Acker was appointed to the staff of the Halifax Children's Hospital as an associate in the Department of Surgery and was allotted twelve orthopaedic beds. Dr Lyons died after being associated with the clinic for six years and was succeeded by John Acker. Acker, after graduation at McGill University and internship at the Montreal General Hospital under Nutter, went to the MacAusland Clinic in Boston for training. He returned to Halifax in 1925. The two brothers, Tom and John Acker, foresaw from their experience in Boston the opportunity of establishing crippled children's clinics in the Maritimes on the same pattern as those in the New England States.

The programme of the Canadian Red Cross Society in their Junior Red Cross Division included work for crippled children, and the Rotary Clubs had the treatment of crippled children as one of their community services. These two groups were brought together, and clinics for crippled children were started. By 1926 eighteen clinics were operating. They were visited at four- or six-monthly intervals and approximately 350 children were examined each year. Some were treated in local hospitals but most were sent to Halifax for special orthopaedic procedures. These crippled children's clinics are still going on.

In November 1949, shortly after the opening of the new Victoria General Hospital in Halifax, an orthopaedic service was established with an out-patient department staffed by John Acker, B. F. Miller and Tom Acker. Miller had recently returned from a course in orthopaedic surgery in England, obtaining the degree of M.Ch.Orth. in Liverpool and the diploma of F.R.C.S. in Edinburgh. The opening of this department in the new hospital further increased the facilities for teaching orthopaedics at Dalhousie University. At the present time there are plans for both the Children's Hospital and the Victoria General Hospital which will add approximately seventy-five orthopaedic beds for the treatment of adults and children.

The director of the Junior Red Cross in Prince Edward Island, Miss Mona Wilson, hearing of the work for crippled children in Nova Scotia, sought assistance in establishing similar clinics there. In 1926, under the sponsorship of the Junior Red Cross, the first clinic was opened, again with the assistance of the Rotary Club. An excellent organisation has developed, and approximately two hundred patients are examined at each clinic. Children who could not be treated in the local hospitals are sent to the Children's Hospital in Halifax for special orthopaedic procedures. As yet there is no orthopaedic specialist resident on Prince Edward Island.

The Department of Health of the Colony of Newfoundland, at the request of the late Dr L. E. Keegan, superintendent of the General Hospital in St John's, arranged to have orthopaedic problems surveyed and treatment carried out by a specialist. In November 1923, Tom Acker went to St John's and organised orthopaedic clinics. From then on regular trips were made, twice and sometimes three times each year. These clinics continued to be sponsored by the Commission of Government when they took over in Newfoundland; they were extended to other centres outside of St John's, including the Grenfell Hospital at Twillingate and the Paper Company Hospitals at Grand Falls and Corner Brook.

In 1937, Louis Conroy, a graduate of McGill University and one of the junior surgeons in St John's, showed interest in this work. He secured a Rockefeller Fellowship for training in orthopaedics at the Steindler and Campbell Clinics and on his return became established in this speciality and carried on the Crippled Children's Clinics. He now has two associates and an orthopaedic ward in the General Hospital.

In the Province of New Brunswick, orthopaedics as a speciality was first introduced by G. G. Corbett who formerly had done general practice in Saint John. About 1930, Dr Corbett went to Boston for a course at the MacAusland Clinic. Returning to Saint John, he opened an office specialising in orthopaedic surgery. He carried on this speciality for a few years

until he was appointed medical officer of the New Brunswick Workmen's Compensation Board. In 1938, E. W. Ewart, after completing a course in orthopaedics at the Steindler and Campbell Clinics, opened an office in Moncton. He has been conducting clinics for crippled children under the Junior Red Cross, covering a large section of the Province. He has an orthopaedic service at the Moncton City Hospital and Hotel Dieu and is orthopaedic surgeon on the staff of the New Brunswick Tuberculosis Hospital. Recently O. J. White, who received his training at Gibson's Clinic in Winnipeg, joined Ewart in the practice of orthopaedics.

ALBERTA

To give a proper background to an account of orthopaedic surgery in Alberta one must convey to the reader how new are most of the present-day institutions in the province. Alberta and Saskatchewan were carved out of the old North-West Territories in 1905. The famous westward march of the North-West Mounted Police took place in 1873. It was not until 1886 that the first transcontinental train ran over the main line of the Canadian Pacific Railway from Montreal to Vancouver. The University of Alberta was established in 1908 and in 1914 pre-medical teaching was started in the Faculty of Medicine. The first students to complete the full medical course in Alberta graduated in 1925.

Before the first world war orthopaedic surgery was included in the work of the general practitioners. Of these the man who had most to do with the development of orthopaedic surgery was F. H. Mewburn. He graduated from McGill in 1881 and spent a year at the Montreal General Hospital. After practising in Winnipeg and Lethbridge he moved to Calgary in 1913 and limited his practice to surgery. During part of the first world war he served as head of the surgical division of No. 15 Canadian Hospital at Taplow, England, with the rank of Lieutenant-Colonel. Returning to Calgary after the war he was appointed Professor of Surgery and it was under his guidance that the department of surgery was organised. He saw to it that the subdivisions of surgery received proper recognition, and the department of orthopaedic surgery became a self-contained unit under its own director.

The first man to limit his practice entirely to orthopaedic surgery was Reggie Deane. He graduated from McGill in 1898 and was later associated with Colonel Mewburn in Lethbridge. In 1911 he moved to Calgary to practise general surgery. After the first world war he studied orthopaedic surgery in England and on his return he specialised in this branch exclusively until his death in 1941.

F. H. H. Mewburn, a son of Colonel Mewburn, was the second individual to confine his practice to orthopaedics. He graduated from McGill in 1914 and after military service in the first world war returned to Edmonton in 1919. Later he studied orthopaedics in Boston and on his return in 1923 he was appointed lecturer in orthopaedics in the University of Alberta. In 1931 he became Clinical Professor of Orthopaedic Surgery. Although he retired from teaching in 1948 he is still in practice.

Graham Huckell was the third orthopaedic surgeon in the province. During the epidemic of poliomyelitis in 1927 he became associated with F. H. H. Mewburn in Edmonton and in 1930 he opened his office for the practice of orthopaedic surgery. He succeeded Dr Mewburn as Clinical Professor of Orthopaedic Surgery.

In recent years a number of younger men, trained in England, the United States and Canada, have returned to Alberta to practise orthopaedics, and the speciality is now well established as a separate branch of surgery. The Alberta Orthopaedic Association was formed in 1948 and meets twice a year, in Calgary and in Edmonton. If till now there have been no new discoveries and little research it is because all our energies have been expended in organisation. The stage is now set for new progress and much will be accomplished in the future.

AUSTRALIAN ORTHOPAEDICS IN THE LAST FIFTY YEARS

H. JACKSON BURROWS, LONDON, ENGLAND *

" Australia has rightly been named the Land of the Dawning "

Before the first world war two men practised orthopaedics in Australia—Colin Mackenzie in Melbourne and Max Herz in Sydney; the first hospital post in orthopaedics was established at the Lewisham Hospital, Sydney, with the appointment of Norman Royle during that war; it was only after 1918 that orthopaedics emerged as a generally recognised branch of surgery with properly trained devotees—rather more slowly perhaps in Melbourne than in the other capital cities.

BEGINNINGS AND EXTERNAL INFLUENCES

Lennox Teece served in the R.A.M.C. at the Military Orthopaedic Hospital, Shepherd's Bush, from 1916 to 1918, and returned to Sydney as the first Australian trained in orthopaedics to practise it as a specialty in his own country. Sir Neville Howse, Director-General of the Australian Medical Services, seeing clearly the orthopaedic problems that would be presented by returning servicemen, arranged for a number of medical officers to attend the special course at Liverpool instituted by Sir Robert Jones and given by Theodore Armour and T. P. McMurray. The selected men caught the enthusiasm of these teachers, occasionally had glimpses of Robert Jones and Joel Goldthwait, and came in contact with young and well-trained orthopaedic surgeons from America. Returning to Australia, Denis Glissan specialised in orthopaedics in Sydney, A. V. Meehan in Brisbane, and later, Alex. Juett in Perth.

In 1924 Sir Robert Jones established a course of studies in the University of Liverpool, leading to the degree of Master of Orthopaedic Surgery. In the first year Edmund Vance was the only member of the class, but later he was joined by Lionel Betts, and Australians have continued to make the pilgrimage since. Thus orthopaedics became firmly established; and, whereas in 1920 there were not, in the whole of Australia, more than five men limiting their practice to orthopaedics, there are now at least thirty trained orthopaedic surgeons in Sydney alone.

In the second world war this branch of surgery was fully recognised. An orthopaedic surgeon was appointed to each general hospital going overseas, and a special orthopaedic unit, comprising John B. Colquhoun, Laurence Macdonald and Bryan Keon-Cohen, worked as a team in the Middle East, for a time at Frankston (Victoria) and then at Toowoomba (Queensland). Denis Glissan, and afterwards John Hoets and Alex. Hamilton, were appointed to 113 A.G.H., Concord. A special orthopaedic hospital (103 A.G.H.) was established at Baulkham Hills under the command of Colonel Roy V. Graham (1889–1950), one of the orthopaedic surgeons of Sydney in the days of peace. A visitor to these establishments was greatly impressed by the excellent administration, the complete arrangements for rehabilitation and the operative skill, no less than by the kind and generous hospitality. The Royal Australian Air Force had a most efficient rehabilitation centre under Wing Commander G. G. Burniston in the former home of the Royal Australian Naval College at Jarvis Bay; it is good to know that this centre, transferred to the Department of Social Services, survives to-day, still under the guiding hand of Burniston.

If in Australia, as in the home country, Sir Robert Jones is the patron saint of

* This contribution might have come more appropriately from an Australian; but it has been written by one with a warm regard for his subject, who has been able to co-ordinate the observations of many Australian friends rather as editor than author.

orthopaedics, T. P. McMurray is remembered as its chief apostle, and almost any argument in orthopaedics can be clinched with an observation beginning " McMurray said—." Doubtless it will soon be found that the mantle has fallen upon Bryan McFarland, for men of a new generation are studying at the Liverpool school where their professional fathers trained and where the great traditions will surely be maintained. Much of the orthopaedics of the United States and the United Kingdom has been absorbed through the literature, and Watson-Jones's book on fractures and the *Journal of Bone and Joint Surgery* probably hold pride of place. Among English undergraduate schools perhaps the best-known have been the Middlesex—for the anatomical teaching of " Timmy " Yeates and his successors, and for the personality of Sir Gordon Gordon-Taylor—and Bart.'s for its clinical teaching.

There is no such thing as spontaneous generation in the development of knowledge and its beneficent application; the links that Australians have forged with other parts of the world and maintained by frequent travel have undoubtedly strengthened their country's own special contributions to medicine in general, and to surgery and anatomy in particular. Some contributions have been the product of a pioneering spirit, still evident in this new land, and standing out brightly against a background of paternal government, strikes and ca' canny; geography has sometimes set problems whose solution has called forth genius; and finally the remarkable natural history of Australia must ever provide a stimulus for the biologically minded. Australian contributions to orthopaedics, as to medicine and science generally, have been made by three groups: the *pommies* or immigrants; the *dinkum Aussies* or Australian born; and the " renegades," who, born in Australia, have emigrated.

THE GIANTS

Hamilton Russell (1860–1933) was born in Kent and migrated to Melbourne in 1889 before it had become one of the great surgical centres of the world. He was a direct bearer of the torch of Lister, and a great surgical teacher. After helping to found the Victorian Association of Surgeons in 1920 he was one of the founders, and the first Director-General*, of the College of Surgeons of Australasia. He made at least one original contribution to orthopaedics that gained world-wide acknowledgment—the mechanical device since called " Russell traction "; this was an embodiment of his physiological principle that, if a fractured limb could be made comfortable, muscle spasm would cease to distort it, so that only the deforming force of gravity remained to be controlled. His respect for the neuro-muscular system found expression not only in emphasis on gentleness but also in condemnation of passive movement. He was a true disciple of Lister, having been his dresser and his house surgeon; this association no doubt developed Russell's especial characteristics of gentleness, idealism and modesty. He always attributed his achievements to the master, and, like him, inspired young men. He was a good speaker and wrote clearly in a conversational manner; he was an exceptionally gifted pianist, and a man of charm and good looks who nevertheless remained a bachelor. Twice it was his fate to be an orthopaedic patient: in the outback he sustained a Colles fracture, which he promptly reduced himself and continued to treat; and in later years he suffered uncomplainingly from osteoarthritis of the hips. He was killed in a motor accident at the age of seventy-three.

William Colin MacKenzie (1877–1938), of Highland descent, was born some forty miles from Melbourne, where he graduated, took his M.D. and became Demonstrator of Anatomy. Setting up in general practice near the University he became Lecturer in Surgical and Applied Anatomy, and also Clinical Assistant at the Children's Hospital, where he acquired a great interest in infantile paralysis to which he brought the insight of one versed in the functional and comparative anatomy of muscle. So stimulated, he visited Vulpius in Heidelberg and Robert Jones in Liverpool who imbued him with the conservative approach. On his return

* The title Director-General was later changed to Censor-in-Chief, and remained so when the College of Surgeons of Australasia became the Royal Australasian College of Surgeons.

to Melbourne, a severe epidemic of poliomyelitis gave him opportunities to develop the principles which were the outcome of his scientific background and studies. In 1917 he again came to England, worked with Arthur Keith at the Royal College of Surgeons, became a voluntary worker at the Military Orthopaedic Hospital, Shepherd's Bush, and within a year published his classic work *The Action of Muscles including Muscle Rest and Muscle Re-education*. Returning to Melbourne, he specialised in orthopaedics; but all his spare time was given to his hobby, the study of the comparative anatomy of the fantastically primitive fauna of Australia. With the constant help of his William Clift—in the person of a cousin, Dr Charles MacKay—he amassed a collection of anatomical material which he gave to the Australian people in 1924. With true enlightenment they housed it, in 1930, in the Australian Institute of Anatomy at Canberra, of which he became the first director. He hoped that it would occupy " in Australia a place in the scientific world like that of the Hunterian Museum." Before this torch-bearer of the Hunterian tradition died he received the honour of knighthood and became the first president of the Royal Society of Australia. MacKenzie clearly drew his inspiration from the Anatomy School of the University of Melbourne, from the orthopaedic schools of Vulpius at Heidelberg and of Hugh Owen Thomas and Robert Jones at Liverpool, from the Royal College of Surgeons of England with its conservator Keith—the apostle of Hunter—and from the great Military Orthopaedic Hospital at Shepherd's Bush inspired by Robert Jones. What was MacKenzie's gift to orthopaedics? He brought to it the hypothesis that paralysis and recovery of muscle are functions of its evolution—an idea that probably few hold now. But he brought to it something much more important, the outlook of an anatomist and physiologist. He coined the term " muscle re-education " and expounded its methods. At a time when physiotherapy consisted largely of massage, forced passive movements and electrical stimulation, he wrote: " The principle cannot be repeated too often that an ounce of scientifically directed volitional effort is worth pounds of passive treatment. With this in mind it is wonderful what can be accomplished in a warm room with the aid of a table, a few pillows, and a sheet of powdered cardboard." He understood the use of rest as the complement, not the antithesis, of active movement. A small by-product of his interest in rest was the shoulder abduction splint, which he was the first to describe in 1908.

Two remarkable Australians in Sydney were responsible for what proved to be at once the birth of the rational surgery of the autonomic nervous system and one of the great disappointments in the history of orthopaedics. Norman Dawson Royle (1888–1944) was by force of circumstances a weekly wage-earner when he left school. On one of his rare opportunities for frivolous entertainment he saw Sandow perform at the old Tivoli Theatre in Sydney. He set about acquiring the art of contracting individual muscles with such success that he could, for instance, make the recti stand out from an otherwise relaxed abdomen, either together or singly. By joining the staff of one of the physical culture establishments that abound in Sydney he was able to save enough money to enter the University as a medical student—rather older than most, and with an avid and serious interest in muscle function; he even went to Melbourne, while still a student, to ask MacKenzie to expound a difficult point in his contentions. After qualifying and holding a resident appointment at the Lewisham Hospital, Sydney, Royle plunged into orthopaedic practice and so gained an outlet for his inquiring, restless mind and his strong critical faculties. He came to know a man of great character and intellectual brilliance, then still a student, John I. Hunter (1898–1924), whose pecuniary battle had equalled his own and who was destined to become Challis Professor of Anatomy in the University of Sydney at the early age of twenty-five (after tutelage with such as J. T. Wilson, Elliot Smith, J. P. Hill and Ariëns Kappers). Together, Hunter and Royle discussed and worked at many neuro-muscular problems, including regeneration of nerve and muscle, muscular activity, reflex action and spinal shock. After the first world war, Royle had much to do with the treatment of returned soldiers and was exercised by

the problems of spastic paralysis, especially after injury. It was known that sympathetic nerves were distributed to skeletal muscles, and there was some evidence that they ended in muscle fibres distinct from those receiving somatic nerves. Whether the sympathetic nerve supply to muscle was concerned with muscle tone was uncertain, because animal experiments had given contradictory results. It had been suggested that postural tone was of two kinds, plastic tone and contractile tone, each dependent upon a reflex arc, the afferent side of which might be sympathetic in the case of plastic tone and somatic in the case of contractile tone. This view had been criticised severely, largely because sympathectomy did not diminish rigidity in the decerebrate animal. However, in decerebrate goats (anaesthetised by another orthopaedic surgeon, J. W. R. Hoets) Royle observed after sympathectomy what he took to be diminution of plastic tone in the corresponding limbs. J. I. Hunter made similar observations in birds; and Royle extended the observations to Man, operating upon patients with spastic paralysis from various causes. He reported good results in cases of wounds and vascular lesions of the cerebral cortex and in cases of spastic paralysis of infancy, variable results in cases of spinal injury, and poor results in progressive spinal diseases. This work commanded universal attention, but unfortunately the results were not confirmed: optimism and the temporary benefit of anaesthesia had been too little regarded. There was no lasting improvement in a series of patients with congenital spastic paralysis operated upon in Great Britain by Royle himself. Even the anatomical explanation was disproved. Nevertheless, the work of Hunter and Royle, though failing in its immediate object, was far from sterile: it bore fruit in the stimulus it gave to surgery of the autonomic nervous system. Valuable contributions were also made, particularly by Hunter, to neurological anatomy and physiology, to embryology and to anthropology. It is of interest to orthopaedic surgeons that Royle devised a special technique for tendon transplantation, using part of the tendon as a living suture; and that as long ago as 1928 he removed a congenitally wedged vertrebra from the spine of a girl aged two and a half years, only two years before increasing disability obliged him to abandon practice.

There is personal tragedy in the story of Hunter and Royle. Together they went to Chicago to deliver jointly the John B. Murphy Oration in October 1924. Thereafter they visited various North American centres where they " met with a veritable triumph." Their work was regarded as an " epoch-making event in the history of surgery "; Cushing recorded that their visit had been heralded unduly by the lay press and that they were greatly embarrassed by widespread misconception of the applicability of their procedure and of the results to be expected from it. During this tour Hunter acquired typhoid fever; he neglected its symptoms, and died * a few days after reaching England. Royle, in Boston, was stricken with encephalitis lethargica, which sentenced him to the relentless servitude of Parkinsonism, a disease whose burden he had vainly sought to lighten in others. From this bondage he was released by coronary disease in 1944, leaving five sons of whom two have entered medicine.

The classic paper of L. O. Betts (1886–1943) of Adelaide upon Morton's metatarsalgia, written in 1940 as the outcome of several years' experience, threw the light of fact upon a condition wrapped in mystery and showed the way to further investigation. Though not the first to demonstrate thickening of the fourth plantar digital nerve in Morton's disease, he was the first to demonstrate it in a series of cases, the first to discover the great increase in the fibrous tissue of the nerve, and the first to advocate resection as the routine operative treatment. Betts was awarded the O.B.E. for his military services in the first world war, and was president of the Australian Orthopaedic Association in 1939. He was a good clinician, with a quiet manner and a sense of humour; his hobby was the staple of his country—sheep and wool—in which he was both an enthusiast and an expert.

* A frequent misconception that Hunter died of encephalitis lethargica has been repeated in print, but the cause of death recorded by Elliot Smith and by Cushing, and subscribed to by Elliot Smith on the death certificate, was enteric fever.

The work of the living is too close to allow a just and proper perspective. We think of Dame Jean Macnamara and poliomyelitis; of Glissan and hallux valgus; of Corlette and the familial incidence of Dupuytren's contracture; of Tom King with his mechanical contrivances; of Teece and Trumble with their splints; of the plastic surgeon, Rank, and cineplastic amputation; and of many others who are making lasting contributions. We think also of the debt of orthopaedics to those in other fields of medicine—for example, N. McA. Gregg who since 1941 has added so much to our knowledge of developmental defects. He observed that many of the mothers of children with a peculiar form of cataract had suffered from a disease indistinguishable from rubella during the first three months of pregnancy. Most of these children had also cardiac defects. Soon other abnormalities were found in the children of similar mothers, the stage of pregnancy at which rubella occurred being correlated with the stage of greatest developmental activity of the part affected. Gregg was probably right in saying that this is " but one chapter in the full story of congenital defects; many more chapters have yet to be written." Another contributor to orthopaedics is that brilliant and versatile surgeon and pathologist, E. S. J. King, whose work on what is usually called osteochondritis juvenilis won for him the Jacksonian Prize of the Royal College of Surgeons of England for the third time, a record that has never been equalled and is most unlikely to be surpassed.

THE " RENEGADES "

This term is used without unkind significance for those who have left Australia, sometimes wandering widely in pursuit of their labours, achieving great distinction and casting on their birthplace a reflected glory. One such was Sir Grafton Elliot Smith (1871–1937), who was born in New South Wales of a brilliant family and came to England at the age of twenty-five. He described Pott's disease in a mummy of 1000 B.C., and established that the bones of ancient Egyptians bore the marks of tuberculosis but not of syphilis.

Nowadays it is difficult to think of the treatment of major accidental wounds without excision; it was not so in the early part of the first world war, and the paper published in June 1915 by E. T. C. Milligan on " The Early Treatment of Projectile Wounds by Excision of the Damaged Tissue " was an important contribution by an Australian. Readers of this Journal are familiar with some of the contributions of William Gissane and J. Grant Bonnin to the orthopaedics of injury, of Miss Dorothy Russell, Rupert A. Willis and Hubert A. Sissons to orthopaedic pathology, and of F. Campbell Golding and Brian W. Windeyer to orthopaedic radiology.

Much paper and celluloid have been lavished on the dynamic figure of Miss Elizabeth Kenny. Little is now heard of her views on cerebral palsy, which were orthodox, but her views on infantile paralysis have promoted wide interest and detailed investigation. With some justice, Albert Key has said of the Kenny treatment, " that which is good is not new, and that which is new is not good "; but Miss Kenny made surgeons think again; and in so far as splinting has too often been misunderstood and misapplied, and in so far as the old principle of moving every joint through its full range every day has often been neglected, her condemnation of the one and insistence on the other have been salutary, if a trifle vehement.

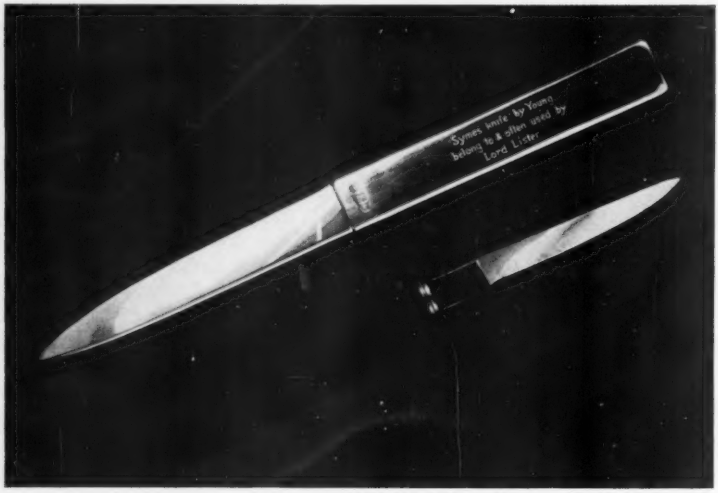
The greatest contribution made by an Australian to orthopaedics, as to all medicine, was Howard Florey's leading part in the development of Alexander Fleming's great discovery.

UNIVERSITIES AND ASSOCIATIONS OF AUSTRALIA

The universities and teaching hospitals of Australia are of a high standard, but they are hopelessly overcrowded because it is almost impossible to exclude any student who surmounts the matriculation examination. There are medical schools at Melbourne, Sydney, Adelaide, Perth and Brisbane. The hospitals have suffered less from poverty and from restriction of

building than those of the United Kingdom; and hospitals such as the Royal Melbourne and some of the repatriation hospitals—for instance those at Heidelberg near Melbourne and Concord near Sydney—are most enviable. A good deal of orthopaedic work is carried out at the children's hospitals of the capital cities, which are notable institutions with sufficient resources to bear the brunt of severe epidemics of infantile paralysis.

The British Medical Association of Australia holds regular meetings of its orthopaedic group in various States. At first it was feared that these might suffer from the formation of an orthopaedic association. The B.M.A. of Australia is a powerful body which has co-operated readily in schemes of social welfare, but, unlike its older sister, has contested successfully that supreme folly of the politicians, free drugs for all.



A Syme's knife by Young, formerly belonging to and often used by Lister. It was presented in 1914 by his nephew and former assistant, Sir Rickman J. Godlee, to a former Listerian house surgeon, R. Hamilton Russell, by whom it was given to Sir Alan Newton. It was presented to the Royal Australasian College of Surgeons by Lady Newton. (The knife has been photographed with its silver case.)

The Royal Australasian College of Surgeons—The College of Surgeons of Australasia, first mooted in 1920 and founded in 1926, became the Royal Australasian College of Surgeons in 1930. In 1932 the Government of Victoria granted a lease of three acres of gardens in Spring Street, on high ground at the top of Collins Street, Melbourne, at an annual rental of £1. Here was erected the beautiful and simple home of the College, with its lecture-theatre and already notable library; it was opened in 1935 by the then President of the Royal College of Surgeons of England, Sir Holburt Waring. The link with the English College has always been close and happy. Among its practical expressions has been collaboration in holding primary fellowship examinations of the Royal College of Surgeons of England in Australia and New Zealand; and more recently (1948) in agreeing reciprocity in the primary fellowship examination. The Great Mace of the Australasian College bears the inscription, " The gift of the President and Council of the Royal College of Surgeons of England, as from brothers to brothers, MCMXXXII." The Australasian College has demanded high ethical and educational standards in its fellows, has insisted upon a primary examination in the basic

sciences and has anticipated the older Colleges by many years in demanding a period of practical apprenticeship before admission. It has used its influence to bring the senior surgical degrees of the various universities to a uniformly high standard; has collaborated with Prince Henry's Hospital in the formation of a postgraduate school in Melbourne; has established a first-class library; and has made provision for research. It holds an annual scientific meeting in the various capital cities of Australia and New Zealand; and it sponsors one of the leading surgical journals of the world, the Australian and New Zealand Journal of Surgery. Finally it awards its fellowship in orthopaedics after a sharp test conducted by orthopaedic examiners, of whom Denis Glissan and Tom King were the first. It acts with the Royal Australasian College of Physicians and the English Royal Colleges in the award of the Arthur Sims Commonwealth Travelling Professorship, which has now been made for the first time to an orthopaedic surgeon, namely Sir Reginald Watson-Jones. The Arms of the College bear the motto, *Fax Mentis Incendium Gloriae*—"The flame of glory is the torch of the mind."

The Australian Orthopaedic Association—The birth of the Australian Orthopaedic Association may be traced to conversations between E. B. M. Vance, his associate A. H. Hamilton and their colleagues in Sydney, which led to a meeting on October 6, 1936, attended by E. B. M. Vance (1885–1939), Alex. Hamilton, J. W. R. Hoets, Norman Royle (1888–1944), Denis Glissan, Laurence Macdonald, F. H. McC. Callow, S. H. Scougall, A. L. Webb and Harold A. Sweetapple (1898–1947). At this meeting it was decided to form an Association. In April 1937, these gentlemen, together with others who confined their practice to orthopaedics—Lennox Teece, L. O. Betts (1886–1943), Roy V. Graham (1889–1950), A. V. Meehan and L. W. N. Gibson (1899–1937)—were declared foundation members, with Vance as president and Hamilton as honorary secretary. The annual meetings are held at one or another of the capital cities and, although some members have to fly no less than 2000 miles each way, are well attended and have produced quite remarkable good fellowship and comradeship. The Association is already interested in research projects and also gives authoritative advice on administrative matters. There are eighty-three members, including fifty-five active members and ten corresponding members. A biennial prize has recently been established, and the first award has been made to Dr Max Lake for his essay "Studies of Osteitis Deformans."

The present writer, who had the privilege of attending a meeting of the Association, was tremendously impressed by its friendly atmosphere, keen enthusiasm, efficient organisation and scientific excellence. Vance, one of the original moving spirits and the first president, was much liked for his mental attributes, quiet, pleasing manner and keen sense of humour. Not only was he the first president of the Australian Orthopaedic Association, but he was the first to gain the M.Ch.Orth., and he remained a stalwart disciple of the Liverpool school. Towards the end of his days he continued to work despite severe attacks of coronary thrombosis, to which he succumbed in 1939 after setting a Colles fracture.

The Australian Physiotherapy Association began in New South Wales in 1905 as the Australian Massage Association, being organised by (among others) the late Professor Anderson Stuart, Dean of the Faculty of Medicine in the University of Sydney. The high standard of work of members of this Association is generally acknowledged, especially perhaps in the skill of many of its members in dealing with infantile paralysis, of which unfortunately they see much.

The Australian Association of Occupational Therapists—At the request of the Hospitals Commission of New South Wales, the Australian Orthopaedic Association established a training school in Sydney for occupational therapists under the direction of Miss Sylvia Docker, A.P.A. By 1946 there were enough graduates for the Australian Association of Occupational Therapists to become autonomous and relieve the Physiotherapy Association of the responsibility of training occupational therapists.

Orthopaedic care of children—Social orthopaedics has developed in much the same way as in the United Kingdom, but with geographical and kindred differences. New South Wales may be taken as an example. In 1929 the Rotary Club of Sydney made a survey to determine the number of crippled children in that city needing care. The outcome was the formation of the New South Wales Society for Crippled Children, which now controls a small hospital, three special schools, a training centre, clubs for older children, a network of clinics and a considerable physiotherapy and welfare staff for the care of about 2000 children. The society is supported by voluntary subscription, amplified by a State grant. It is linked with kindred societies in three other cities; and similar services are conducted for the rest of the State by the Far West Children's Health Scheme. This body, besides maintaining a systematic search for handicapped children in the enormous area of 350,000 square miles, arranges for their collection at suitable centres and for visits by specialists from Sydney in consultation with the country doctors. Children needing hospital treatment are brought to the Society's home at Manly, one of the beaches, whence they enter one of the metropolitan hospitals and whither they can return for convalescence. About two-thirds of them have major orthopaedic disabilities. Besides a surgical appliance workshop the home has facilities for physiotherapy, occupational therapy, speech therapy and schooling at kindergarten, primary and high school levels. Nearly 5000 children have passed through the home. Another interesting activity of the Society is a seaside camp restricted to children who live more than 300 miles inland and have never seen the sea.

In 1945 a Spastic Centre was established at Mosman, Sydney, by a group of parents of spastic children. Only children with cerebral palsy whose intelligence is about normal are eligible. A few from the country are boarders; one hundred others are collected five days a week by bus. Half the day is devoted to schooling and half to treatment, which is re-educational in character and includes speech-therapy. Medical direction is by an orthopaedic surgeon assisted by a paediatrician. There are no fees, but every mother gives two days' domestic help each week, and every father two days' maintenance work each month. In building the centre the fathers are said to have "commenced" to remove 3000 tons of clay; nevertheless, all credit to them, they did in fact move 400 tons of bricks and 10,000 tiles without loss of life.

THE FLYING DOCTOR SERVICE

This monument of vision and energy, which has not only brought medical aid to the outback but has transformed it socially, sprang from a small beginning. The story is perhaps worth telling. The small legacy of a Mrs Smith of Dunesk, Lasswade, near Edinburgh, lay and grew for forty years. Its discovery enabled the Presbyterian Church of Adelaide to embark in 1895 upon a missionary endeavour that took the Reverend Robert Mitchell, with his daughter and an organ in a covered buggy, a thousand miles towards the middle of the Continent. The needs that he and his successors found led in 1906 to the establishment of a nurse at the railhead, Oodnadatta. Here was built in 1911 the first nursing hostel or home in the outback. Robert Mitchell was joined by the Reverend John Flynn, who persuaded the Presbyterian Church of Australia to found the Australian Inland Mission, an undenominational body devoted to the medical and social welfare of the pioneers of the outback. Gradually nursing hostels were opened in other outposts; but the needs of the vast areas covered by these hostels could never be met without medical aid, and the problem, even greater than that of transporting a doctor, was how to summon him. Transport could be arranged by air, but the summoning had to await improvements in radio-telegraphy. Through the efforts of Alf Traeger and others there was first perfected a pedal wireless telegraph which transmitted in Morse from an alphabetical keyboard; later it was superseded by a pedal radio-telephone. In 1927 the A.I.M. Aerial Medical Service was founded, and a year later the first flying doctor, K. St. Vincent Welch, chosen from twenty-one applicants, was based at Cloncurry in western

Queensland. In 1929 the first pedal wireless station was installed at Augustus Downs. Since then, six more flying doctor and radio centres have been established, the last at Alice Springs in the centre of the Continent. Most are (non-profit-making) public companies, limited by guarantee and incorporated in their respective States. They are co-ordinated as part of the Flying Doctor Service of Australia by a Federal Council, with two members from each State. The coming of radio to the outback, primarily to call the doctor, has brought some of the loneliest people on earth into touch with one another and the rest of mankind.

The Flying Doctor bases of Australia, with a comparable map of Europe superimposed.

NATURAL HISTORY OF AUSTRALIA

In speaking of the sources of inspiration of Australian orthopaedics we have referred to the stimulus of a new country, the challenge of open spaces and the influence of older countries. There is also the stimulus of an almost incredible natural history in this land of "living fossils" which can still bring a fervent outlook to the medical man who, like Hunter and Jenner, has his roots in nature, and which has brought freshness and vigour to the mode of Australian scientific and medical thought—to pure anatomy perhaps above all. As at home, poets and writers have painted these wonders in their brightest colours; but what Marcus Clarke wrote of the beauty of the prehistoric world that survives in Australia's plants and animals is equally true of the science.

"There is a poem in every form of tree or flower, but the poetry which lives in the trees and flowers of Australia differs . . . Europe is the home of knightly song, of bright deeds and clear morning thought. Asia sinks beneath the weighty recollection of her past magnificence . . . America swiftly hurries on her way, rapid, glittering, insatiable . . . From the jungles of Africa arise, from the glowing hearts of a thousand flowers, heavy and intoxicating odours . . . In Australia alone is to be found the Grotesque, the Weird, the strange scribblings of Nature learning how to write. Some see no beauty in our trees without shade, our flowers without perfume, our birds who cannot fly, and our beasts who have not yet learned to walk on all fours. But the dweller in the wilderness acknowledges the subtle charm of this fantastic land

of monstrosities . . . whispered to by the myriad tongues of the wilderness, he learns the language of the barren and the uncouth, and can read the hieroglyphs of haggard gum-trees . . . The phantasmagoria of that wild dreamland termed the Bush interprets itself, and the Poet of our desolation begins to comprehend why free Esau loved his heritage of desert sand better than all the bountiful richness of Egypt."

There is scientific inspiration, no less than aesthetic, "In lands where bright blossoms are scentless, And songless bright birds." *

It is a pleasure to acknowledge the help received from many Australian friends, including Mr Denis Glissan, Mr McKellar Hall, Mr A. H. Hamilton, Mr Norman Little and Mr Laurence Macdonald. The photograph of the Syme's knife formerly belonging to Lister was kindly provided by the Royal Australasian College of Surgeons, to whose Secretary, Mr H. G. Wheeler, the writer is beholden for many courtesies. Much literary help has been given by Mr P. Wade of the Royal Society of Medicine, Consulting Librarian to the Institute of Orthopaedics, and by Mr C. Davenport, Librarian to the Institute.

* Mistaken for a generalisation, this phrase has been much criticised, but Adam Lindsay Gordon also wrote:

"In the spring, when the wattle gold trembles 'Twixt shadow and shine,
When each dew-laden air draught resembles A long draught of wine."

THE FIRST HALF-CENTURY OF ORTHOPAEDIC SURGERY IN NEW ZEALAND

COATES MILSOM, AUCKLAND, NEW ZEALAND

It is perhaps not surprising that in this country, with a population of less than two millions, enjoying such ample living space and with diet so abundant, the incidence of orthopaedic disorders is low. This is one of the reasons why original clinical contributions from New Zealand have been limited, and why many of our surgeons have sought postgraduate training overseas. Nowhere are the ties of Empire more strong, and such training has usually been gained in England. Not a few of our surgeons have stayed there and, although it is a loss to their home country, we still take pride in their achievement: Sir Harold Gillies, whose pioneer work in plastic surgery has gained world renown; Sir Archibald McIndoe and Rainsford Mowlem, who enhanced that reputation; and many others to whom reference is made in this article.

Even before orthopaedic surgery was known in this country an important contribution was made by Sir Frederic Truby King who applied scientific principles to the feeding and welfare of children and their mothers. He founded the Royal New Zealand Society for the Health of Women and Children, organised mothercraft centres in many parts of the world and even in such distant parts as London itself, and was directly responsible for preventing many of the disorders that would otherwise have necessitated orthopaedic treatment.

The First World War—Before the first World War, orthopaedics was not recognised as a special branch of surgery, but the opportunity was then presented to many surgeons who trained under the great Sir Robert Jones. Courses were organised by him and by R. C. Elmslie at the Military Orthopaedic Hospital at Shepherd's Bush, Alder Hey Hospital in Liverpool, and the Orthopaedic Hospital at Baschurch where they made the acquaintance of Dame Agnes Hunt. Colonel D. S. Wylie was entrusted with development of the first New Zealand Military Orthopaedic Unit, and Renfrew White, Wallis, Mill, Ulrich and Gower who trained with him must be named as the first orthopaedic surgeons of New Zealand. Supplied with British equipment and accompanied by plaster technicians, ward sisters and a massage staff they returned in 1918 and forthwith established a unit at Christchurch.

Renfrew White was quickly appointed to the staff of the Dunedin Hospital as clinical teacher and lecturer in orthopaedic surgery, and he carried out these duties until his retirement in 1949. His influence upon successive generations of students, with the stimulus of his incisive teaching which made them think for themselves, has been one of the greatest contributions towards the development of orthopaedics. He will be remembered also for his masterly technique, his writings, and his insistence on the cultural education of students.

In 1920 two more hospitals were opened at Trentham and Rotorua for the treatment and rehabilitation of returned servicemen. At the King George V Hospital at Rotorua, W. S. Wallis was appointed superintendent and orthopaedic surgeon; from what was at first a purely military orthopaedic establishment he made an important centre of treatment of civilian orthopaedic cases and finally a general hospital for the district. The original military orthopaedic unit stood in the grounds of the Christchurch Public Hospital which later took it over and developed an orthopaedic department under the guidance of Leslie Will, who arrived back from a period of training in England a year or two later.

From these early beginnings we may pass to the " middle period " marked by the arrival of Alexander Gillies in Wellington in 1929. Like the original six, he had trained in England and had also spent some years in the United States of America. The influence of Hugh Owen Thomas and Robert Jones was thus reinforced. Gillies has been responsible for the guidance and development of the New Zealand Crippled Children's Society, and to him must be attributed the development of travelling clinics for the early detection of orthopaedic

conditions in children. This period is also associated with the names of Walter Robertson in Wellington, and of Cuthbert McCaw and Keith Macky in Auckland.

Influence of the Second World War—Each of the three general hospitals of the New Zealand Division in the Middle East had on its staff one orthopaedic surgeon drawn from the ranks of assistant surgeons of the metropolitan hospitals. Each hospital cared for its own quota of major fractures and orthopaedic cases. Of the junior medical officers attached to the orthopaedic wards, many became interested in the pursuit of the specialty. In New Zealand itself, civilian hospitals were expanded and civilian orthopaedic surgeons undertook the care of the returned wounded besides their ordinary duties. With the outbreak of war in the Pacific area, the United States Forces established several large field-hospitals in the country, and New Zealand surgeons thus acquired a valued opportunity of comparing their practice with that of another nation. Clinical demonstrations and meetings gave a broader outlook, especially in the matter of equipment and appliances.

Now, in 1950, the position has been reached where the desire to emulate these pioneers has encouraged many graduates to seek orthopaedic training in Great Britain. Not only the main cities but many of the smaller towns now possess separate orthopaedic units. At Auckland, the largest city, there are on the Staff of the General Hospital three senior and three assistant orthopaedic surgeons, one full-time resident senior orthopaedic surgeon and a registrar. No less than seven former house surgeons of the hospital are now training as orthopaedic surgeons in England.

Physiotherapy, Rehabilitation and Resettlement—The scheme for rehabilitation of wounded servicemen has been highly successful. Severely handicapped men were first tested in departments of occupational therapy to discover their capabilities. Less handicapped patients were sent directly to training schools after examination by vocational guidance officers; they learned carpentry, bootmaking, artificial-limb making, bee keeping, poultry farming, french polishing and cabinet-making. Occupational therapy was instituted during the latter part of the war. A training school was developed, and occupational therapists are now available in most of the main hospitals and are doing especially useful work in the mental hospitals and with geriatric patients.

In the early days massage was practised by privately trained and sometimes untrained individuals, but in 1920 the Masseurs Registration Act was passed; later a school of physiotherapy was established in Dunedin from which graduates have travelled far from New Zealand. The recent Physiotherapy Act of 1949 has consolidated the position of these trained medical auxiliaries whose work is valued so highly.

The Crippled Children's Society—The Wellington Rotary Club, after an address by Alexander Gillies in 1930, investigated the Crippled Children's Movement in the United States of America which was started in 1913 by the Rotary Club of Syracuse. By 1935 the New Zealand Crippled Children's Society was formally established, and supported by contributions from local Rotary Clubs and the generosity of the Wilson family; Lord Nuffield later made a magnificent donation which formed the Nuffield Trust Fund. The Society in 1948 had nearly five thousand cases on its register and had become a national organisation. Working with the Department of Health it undertook the welfare, diagnosis, treatment and vocational training of crippled children. To facilitate the detection of untreated cases in country areas a system of travelling clinics had been created in 1932, inspired by the Shropshire clinics of the Robert Jones and Agnes Hunt Orthopaedic Hospital in England. These clinics are now country-wide. Though it was estimated in 1948 that there were still two thousand untreated cases, the clinics have already reaped a harvest and many thousands of crippled children—who otherwise would never have been seen—have been cured. Crutches, wheel chairs, special footwear and clothing have also been provided; and the Wilson family have maintained their generosity in giving their beautiful home and grounds in Takapuna as a Children's Orthopaedic Home.

The National Health Scheme—To New Zealand belongs the credit—some say the discredit—of establishing the first National Health Scheme. It is difficult yet to assess the effects of this experiment upon orthopaedic practice. At first, the knowledge that hospital accommodation was free caused serious overcrowding and at one time waiting lists for admission were quite ridiculously long. This situation is now being improved, but only through extensive building. One such new hospital at Middlemore near Auckland has been designed primarily as a special orthopaedic hospital. With large and airy six- and four-bedded wards, and with almost palatial accommodation for staff, it is a notable piece of hospital architecture.

The Health Scheme, with its remuneration arranged according to the number of patients seen each day, has been charged with responsibility for lowering the standard of specialist practice; but surely, if this were the case, fewer graduates would choose to spend several years seeking special training in England rather than taking up general practice with its promise of early financial reward.

The New Zealand Orthopaedic Association—Because of the sparsity of population, New Zealand cannot support a large number of cultural societies. Until recently, orthopaedic surgeons have had to depend upon local hospital clinical societies and upon the Royal Australasian College of Surgeons, whose members in New Zealand hold an annual general meeting at which orthopaedic papers are presented. This year the New Zealand Orthopaedic Association has been created under the patronage of Renfrew White and the presidency of Alexander Gillies. Its constitution resembles that of the British Orthopaedic Association. At the turn of the half-century the Association is still in the stage of creation. It values highly the recognition that has been afforded by the American and British Orthopaedic Associations and by the Journal of Bone and Joint Surgery, and it looks forward to the account that may be rendered at the turn of another half-century—A.D. 2000.

Special aspects of orthopaedic practice in New Zealand—Clinical material may not be abundant in New Zealand but certain orthopaedic conditions are more predominant than in Great Britain. Poliomyelitis is both endemic and epidemic. The epidemic disease is characterised by a high incidence of meningitic and encephalitic symptoms. During the recent epidemic, muscle spasm was found in almost every patient admitted to hospital. The 1948 epidemic produced some one thousand proven cases in a population of less than two millions and the proportion of undiagnosed morbidity to the number of proved cases was three hundred to one. Other unusual features of this epidemic were its persistence during the winter months, and the relatively high proportion of adults affected. The Department of Health and the profession as a whole took steps to control the epidemic by preventing public gatherings of children, prohibiting swimming in polluted waters, instructing the public to report minor morbidity to their doctors, and establishing a panel of consultants to screen suspects before admission to hospital. This last feature was most necessary in order to prevent catastrophic overcrowding of hospital accommodation.

Osteomyelitis—Another problem that seems to be peculiar to New Zealand is the unusually high incidence of acute haematogenous osteomyelitis with a seasonal incidence often associated with septicaemic manifestations. Taine (1947) reported thirty cases in the Auckland Hospital in one year, fourteen with staphylococcal septicaemia. The introduction of penicillin and other antibiotics has materially altered both the incidence and the prognosis of the "New Zealand disease." Nevertheless the annual report of the Crippled Children's Society this year shows that in 105 out of 1,581 children, the disability was from osteomyelitis.

Constitutional diseases such as rickets, scurvy and syphilis are seldom seen, and congenital anomalies other than club foot are infrequent. Tuberculosis of bones and joints is less common and, except in the Maori people, less formidable than in Britain.

Other contributions—Reference has already been made to the contributions of Harold Gillies, Archibald McIndoe and Rainsford Mowlem in the field of plastic and maxillo-facial surgery, and the transplantation of bone and cartilage. In 1936 James Jenkins of the Dunedin

Hospital reported successful manipulative reduction of spondylolisthesis in a youth aged sixteen years and lumbo-sacral fusion by the transperitoneal route. In 1948 Batchelor of Guy's Hospital reported excision of the head and neck of the femur combined with subtrochanteric osteotomy of the Schantz type in selected cases of hip disorders, particularly ankylosing spondylitis, old fracture-dislocations of the hip and some cases of osteoarthritis and suppurative ankylosis of both hips; and he has also made contributions on the arthrography and treatment of congenital dislocation of the hip. From the Neurosurgical Unit in Dunedin Hospital, under Professor Falconer, there has originated a study of the diagnosis, radiography, surgery and results of treatment of lumbar intervertebral disc protrusions, published as a trilogy in the British Journal of Surgery. In 1948 K. I. Nissen, now of London, drew attention to the work of Betts on plantar digital neuritis and attributed the nerve lesion to ischaemia from preceding degenerative changes in the corresponding artery. The tragic death of W. B. Highet during the recent war cut short the promise of a New Zealander who in Oxford had already contributed valuable studies; in 1941 he won the Jacksonian Prize for his essay " Injuries to Peripheral Nerves with Special Reference to the Late After-results "; and his contributions to the Lancet (1942) and the British Journal of Surgery (1943) showed the quality of work that would have been maintained if he had lived. Renfrew White's handbook *Orthopaedic Physical Signs and Bandaging* is familiar to students of the Otago Medical School. Morris Axford of Auckland discussed " Some Observations on the Cervical Sympathetic in Man " in 1928; Taine wrote an important article on " Penicillin in the Treatment of Acute Osteomyelitis " in 1947; and in the field of orthopaedic radiology, Richard Dawson has contributed a useful technique for recording accurately the length of limbs.

New Zealand is making a contribution to orthopaedic surgery not only in the developments that may be seen in this country but also through the work of her sons in other countries, particularly England.

Although this article appears over my name, my share has really been no more than to act as a type of sub-assistant-editor to senior colleagues: Mr Alexander Gillies of Wellington, Dr W. S. Wallis of Rotorua, and Mr Allan Macdonald, Mr Selwyn Morris and Mr Morris Axford of Auckland.

REFERENCES

Axford, Morris (1928): Some Observations on the Cervical Sympathetic in Man. Journal of Anatomy, **62,** 301.

Batchelor, J. S. (1939): Discussion on Congenital Dislocation of the Hip. Proceedings of the Royal Society of Medicine (Section of Orthopaedics), **32,** 1299.

Batchelor, J. S. (1948): Excision of the Femoral Head and Neck for Ankylosis and Arthritis of the Hip. Postgraduate Medical Journal, **24,** 241.

Begg, A. C., Falconer, M. A., and McGeorge, M. (1946): Myelography in Lumbar Intervertebral Disc Lesions. British Journal of Surgery, **34,** 141.

Dawson, R. (1948): Paper contributed to degree of M.Ch.Orth. (Liverpool).

Falconer, M. A., McGeorge, M., and Begg, A. C. (1948): Surgery of Lumbar Interbertebral Disc Protrusion. British Journal of Surgery, **35,** 225.

Gillies, H. (1920): Plastic Surgery of the Face. London: Henry Frowde, Oxford University Press.

Highet, W. Bremner (1941): Jacksonian Prize Essay.

Highet, W. Bremner (1942): Splintage of Peripheral Nerve Injuries. Lancet, **1,** 555.

Highet, W. Bremner, and Sanders, F. K. (1943): The Effects of Stretching Nerves after Suture. British Journal of Surgery, **30,** 355.

Jenkins, J. A. (1936): Spondylolisthesis. British Journal of Surgery. **24,** 80.

King, Truby (1938): Obituary. New Zealand Medical Journal, **37,** 94.

Mowlem, Rainsford (1941): Bone and Cartilage Transplants. British Journal of Surgery, **29,** 182.

Mowlem, Rainsford (1944): Cancellous Chip Bone-Grafts. Lancet, **2,** 746.

Nissen, K. I. (1948): Plantar Digital Neuritis. Journal of Bone and Joint Surgery, **30-B,** 213.

Taine, G. J. (1947): Penicillin in the Treatment of Acute Haematogenous Osteomyelitis. New Zealand Medical Journal, **46,** 178.

THE DEVELOPMENT OF ORTHOPAEDIC SURGERY IN SOUTH AFRICA DURING THE PAST HALF-CENTURY

J. M. Edelstein, Johannesburg, South Africa

The development of orthopaedics as a special branch of surgery is comparatively recent in all countries, especially in South Africa where in some respects we still live in pioneering days. At the turn of the century this country was in the throes of the Anglo-Boer War. On its termination, a few British military surgeons settled here and there as general practitioners and later, as the population grew, as general surgeons who no doubt retained from their military experience some special interest in traumatic surgery. The tempo of medical development was slow; it was even slower than the rate of increase of population. In Cape Colony, the oldest of the provinces that were to become the Union of South Africa, there settled in Cape Town in the early years of the century a Dr E. Simon who had some training in orthopaedics in Germany by Hoffa, himself a South African who settled in Germany. Though engaged in general practice, Simon occupied as much of his time as scope permitted with orthopaedics and in due course he devoted himself entirely to that branch of surgery.

The first South African-born citizen to practise as an orthopaedic surgeon in this country was P. de V. Moll. After graduating in Germany he remained to receive orthopaedic training under Vulpius in Heidelberg, and returned to Cape Town in 1919 where he engaged in specialist orthopaedic practice until his death from a motor accident in 1934. A year or two after his return from Europe he was appointed visiting orthopaedic surgeon to the New Somerset Hospital and thus became the first orthopaedic surgeon to be associated with a public hospital.

In Pretoria, Dr E. F. Sthamer practised from 1915 as a general surgeon and, by virtue of his training on the Continent, showed a special leaning towards orthopaedics. Later he restricted himself to such work and became honorary orthopaedic surgeon to the Pretoria General Hospital, in which capacity he served for some years.

In Johannesburg, which with the development of the goldfields soon outstripped other centres in size and population, and shortly after the first World War began to attract specialists in various branches of medicine, there was no orthopaedic surgeon until F. P. Fouché started practice in 1925. Having graduated in Edinburgh he returned to Britain after a period of general practice in the Orange Free State and was associated for several years with Trethowan at Guy's Hospital. He was the first South African orthopaedic surgeon to be trained in the British school of orthopaedics. It took many years to break down the resistance of general surgeons who at that time included orthopaedic work in their activities, and it was not until 1927 that he was appointed to the staff of the General Hospital, and then only on the general surgical staff as an assistant in charge of orthopaedic cases. Later he was appointed honorary orthopaedic surgeon and, in 1935, when a full orthopaedic department was established in the General and Children's Hospitals, he served as head of the department until his retirement in 1946. Meanwhile a few others had gone to Britain to train as orthopaedic surgeons under Robert Jones, McMurray and other surgeons of the Liverpool school, the first British centre to institute a special course of such training. Some went to London, Oxford and other centres, and on their return settled in Johannesburg or Cape Town which were then the only two cities that could support them.

With the establishment in practice of the first half-dozen orthopaedic surgeons the neglected care of cripples received its first attention. Apart from the establishment in 1932 of the Princess Alice Home of Recovery for Children, and in 1933 of the Lady Michaelis

Orthopaedic Home for Children, both in Cape Town and both supported by private enterprise, the rest of South Africa was oblivious to the need of specialised institutions for the treatment and rehabilitation of physically disabled children. In response to appeal, the public awakened to the problem, and in 1936 it was possible to establish in Johannesburg the Hope Training Home for Crippled Children—the first such institution in South Africa where in addition to schooling and vocational training, orthopaedic treatment was provided for disabled children from all over the Union. It was not until 1937 that the magnitude of the problem of cripple care as it existed in South Africa was revealed in its true proportions. In that year, after a first-hand survey by Professor Girdlestone, Lord Nuffield gave £100,000 towards the development of a comprehensive orthopaedic service in South Africa. This country generally, and those interested in the development of orthopaedic surgery in particular, owe a deep debt of gratitude to this benefactor. It is no exaggeration to say that his munificent generosity advanced by many decades the progress of orthopaedic surgery and the treatment of the disabled.

The announcement of the gift had immediate repercussions. The need for adequate orthopaedic services was given publicity and became the concern of all public-spirited citizens. It soon became apparent that South Africa, with its two million European population * scattered widely in small communities over a vast country, and its nine million non-European black population for whom the white man's medicine was still largely a closed book, and among whom were many neglected cripples, had problems of special difficulty in the organisation of adequate orthopaedic services. The Union Government suggested that the fund would best be administered by establishing a national organisation, and at a congress of interested bodies, held in Bloemfontein in 1939, the National Council for the Care of Cripples in South Africa was established. Eight constituent Cripple Care Associations were created throughout the country by which to foster the development of local orthopaedic facilities.

The Nuffield Fund was used to subsidise after-care homes, to establish rural orthopaedic clinics, and to organise the treatment of the Black, Coloured and Indian populations. Great difficulties were encountered in overcoming ignorance and creating machinery by which to discover neglected cripples and bring them to centres where there were facilities for treatment. The gift was used also for the establishment of lectureships in orthopaedic surgery at the University of Cape Town and the University of the Witwatersrand in Johannesburg, as well as for the initiation of postgraduate training courses in orthopaedics at these universities. It also paved the way for the settlement of orthopaedic surgeons in other parts of the country. In collaboration with provincial authorities it subsidised qualified orthopaedic surgeons who wished to establish themselves in the smaller cities. Through such encouragement Durban, Bloemfontein, Port Elizabeth, and Lovedale in the heart of a native reserve, acquired their first orthopaedic surgeons.

The Nuffield gift also provided funds for the training of orthopaedic technicians, and it subsidised research in orthopaedic surgery and the establishment of a special course in orthopaedic nursing in Cape Town. Though the money is now exhausted the National Council for the Care of Cripples, originally brought into being as an instrument for the administration of the Nuffield Fund, conscientiously and vigorously maintains a comprehensive programme of cripple care which is supported generously throughout the country by public donation.

Orthopaedic departments were established in the general hospitals of all the larger cities and by 1944 Durban, Bloemfontein, Pretoria and other centres had fully functioning

* For those readers who have not yet visited the Union of South Africa and are not wholly familiar with the races, it might be explained that it is customary to refer to all white people as Europeans and to all Blacks, Indians and mixed Coloured races as non-Europeans. Thus a non-European hospital caters for all those who are not white. The natives, sometimes referred to in this contribution as the Blacks or the indigenous races, are nine millions in number; the mixed Coloured races and the Indians constitute a relatively small number. The White or " European " population totals two millions.

orthopaedic departments in their hospitals in addition to those already existing in Cape Town and Johannesburg. The institution of postgraduate training courses in the medical schools, especially in Johannesburg, has afforded a much-needed increase in orthopaedic personnel in various hospitals throughout the country and even farther afield—for two surgeons trained in Johannesburg have recently established pioneer orthopaedic practices in Bulawayo and Salisbury, the major cities of Rhodesia.

Undergraduate teaching in Cape Town and Johannesburg has made rapid progress both in scope and volume. At both medical schools orthopaedic surgery is now established as an important part of the general medical curriculum. With the creation in 1940 of a third medical school in the University of Pretoria, undergraduate as well as postgraduate instruction has been pursued actively. At all three teaching hospitals (Johannesburg but recently falling into line) the fracture departments are conducted by orthopaedic surgeons who also instruct undergraduates in this branch of orthopaedics.

In 1939 the Transvaal Chamber of Mines established in Johannesburg the first traumatic hospital in South Africa. This hospital caters for all workers engaged in gold mining on the Witwatersrand, and recently it has extended its facilities to those working on the newly discovered Orange Free State goldfields. It is a hospital equipped on the most modern lines for traumatic work, and all bone and joint injuries are dealt with exclusively by a staff of orthopaedic surgeons. In the period from 1941 to 1946 a large section of this hospital was set aside for the orthopaedic treatment of serious casualties from the various war fronts in which South African troops were engaged.

Of most recent development is the establishment of orthopaedic departments in the non-European Hospitals of Johannesburg, Cape Town, Pretoria, Durban and other large centres. The creation of these departments, staffed by competent orthopaedic surgeons and embodying out-patient clinics, is quickly wearing down the prejudice based on ignorance and fear which the indigenous races have hitherto displayed towards European surgery; and indeed, the demand for orthopaedic treatment by non-Europeans is increasing so rapidly that the facilities are being outstripped. Despite the availability of a number of local trainees, reinforced by some post-war arrivals trained in Britain, the numbers are still inadequate to cope with the tasks that lie ahead in so great a territory. The vast reserve of orthopaedic material that exists in the Black native races, which as yet has barely been probed, offers much for the enrichment of orthopaedic knowledge if only it could be investigated properly and be utilised in research. There is almost no limit to the possibilities. Pathological curiosities and grotesque deformities from bone and joint injuries, tuberculosis, rickets, and other conditions, which probably are familiar to our colleagues overseas only through illustration in the older text-books, are still prevalent among these races. Curiously enough, though neglected victims of poliomyelitis are to be found among them and sometimes with the most deplorable residual deformities, this disease of which we in South Africa have unhappily had several serious epidemics in recent years, is, for reasons that are quite unknown, relatively uncommon in the native. As the result of a severe epidemic in 1948 a public appeal was launched in South Africa for the establishment in Johannesburg of a Poliomyelitis Research Foundation, and a sum of nearly half a million pounds was raised in a very short time. Not the least of the investigations that are to be made will concern itself with the mystery of the comparative immunity of the indigenous population to viruses of this disease.

Modest though the contribution of South Africa has been to the advancement of orthopaedic surgery in the past half-century, there is good reason to believe that a road towards greater and more rapid progress has been built for future years.

ORTHOPAEDIC SURGERY IN SOUTHERN RHODESIA

J. H. G. Robertson, Bulawayo

This summary of orthopaedic surgery in the self-governing Colony of Southern Rhodesia must necessarily be brief, for only sixty years have elapsed since the founding of the Colony. Much traumatic surgery must have been done in the early days by all the pioneer doctors under extremely difficult circumstances, but it was only just before the first world war that facilities for major surgery became available.

The few surgeons had perforce to undertake all types of work including orthopaedics. The names of Dr A. M. Eaton in Bulawayo, and Dr A. M. Fleming, first Medical Director of the Colony and Mr (later Sir) Godfrey Huggins, now Prime Minister, in Salisbury, are associated with this period which extended to the middle thirties. Other surgeons joined their ranks as the Colony progressed. Since those days such steady progress has been made that in Salisbury there are now three and in Bulawayo two surgeons who devote all their time to orthopaedics.

Their work has been made possible by the provision by the Government of modern European hospitals with up-to-date facilities. Medical services for the Africans, to whom all hospital treatment is free, are provided by the Southern Rhodesia Government Medical Service, which is a body entirely distinct from the Colonial Medical Service, but the services of the specialist consultants are used when required by the Government Medical Officers.

All the curative institutions of the Colony are provided and equipped by the Government. The African side is based on a scheme which provides at least one medical officer for each of the twenty-seven native districts. Each medical officer station has a hospital or central clinic and three or four subsidiary clinics. These clinics have from twenty to two hundred beds and are staffed by Africans under the medical officer's supervision. From these there is a centripetal stream of cases to the district hospitals and, if necessary, on to the more highly specialised facilities of the provincial hospitals.

At first suspicious of European ways, the African shows increasing partiality for western medicine and surgery to an extent which is now embarrassing, and it has become impossible to avoid overcrowding in all the hospitals. Hence the Government has embarked on two new African hospitals—with an ultimate capacity of 1,200 beds—in each of the main centres, Salisbury and Bulawayo. These are being constructed on a unit principle and the maternity sections in each centre are already functioning. Next will come large scale out-patient departments and thereafter ward blocks, which will include special accommodation for orthopaedic cases. In the meantime accident and fracture clinics are already functioning under very unfavourable circumstances in the existing buildings. In Bulawayo the surgeon in charge of the African hospital is a trained and experienced orthopaedic surgeon, but is also responsible for much of the general surgery.

Many of our problems are peculiar to the country and to the people. Reliable statistics are unobtainable but clinical impression confirms the observation made in other parts of South Central Africa that the incidence of tuberculosis in all its forms is increasing rapidly. All too many of our patients when admitted are in an advanced stage with secondarily infected joints. The African does not stand prolonged hospitalisation well and where possible we practise early arthrodesis. A sanatorium for Africans has recently been opened in the northern province of Mashonaland and another is foreshadowed to serve the needs of Matabeleland in the South-West.

Osteomyelitis is very common—confirming Trueta's dictum that its incidence is in inverse ratio to the amount of soap used in any population. Our experience is that the acute osteomyelitis of childhood is rare; the type seen is usually insidious in onset and when advice is sought by the adolescent or young adult the condition has been present for some years. Multiple acute septic arthritis is by no means uncommon, and is often complicated by pathological dislocation if the hip is affected. When it has proceeded to quiescence untreated this condition is responsible for some bizarre crippling. The incidence of syphilis is high and its bone and joint manifestations correspondingly so. There is an interesting field here for observations on the influence of active syphilis on callus formation and fracture healing generally.

One is again hampered by lack of statistics but there is little doubt that congenital abnormalities of all sorts have a higher incidence among the African than in European countries. Extra digits and syndactyly abound. Apathetic in many things that concern them vitally the native mothers are surprisingly good at bringing in their club-footed infants

European Hospital, Bulawayo.

for manipulation and plastering. One has seen the statement made that the African races are little subject to poliomyelitis and practically unaffected by congenital spastic palsies. Personal observation does not confirm this: the African is definitely subject to these conditions as he is to the muscular dystrophies and atrophies. Rare in Africans but not uncommon in Europeans, especially in Mashonaland, are the bone and joint manifestations of brucellosis.

The Government maintains an orthopaedic workshop in Salisbury serving the needs of all sections of the population and artificial limbs for African amputees are obtainable and paid for from Government funds through a special fund. The lack of organised rehabilitation facilities for Africans is a factor which hampers our efforts in many directions, but there is hope that in the not too distant future a start may be made towards the provision of these services. A move is now being made to provide a large scale rehabilitation centre for Europeans in Salisbury.

HALF A CENTURY OF ORTHOPAEDIC PROGRESS IN GREAT BRITAIN

H. Osmond-Clarke, London, England

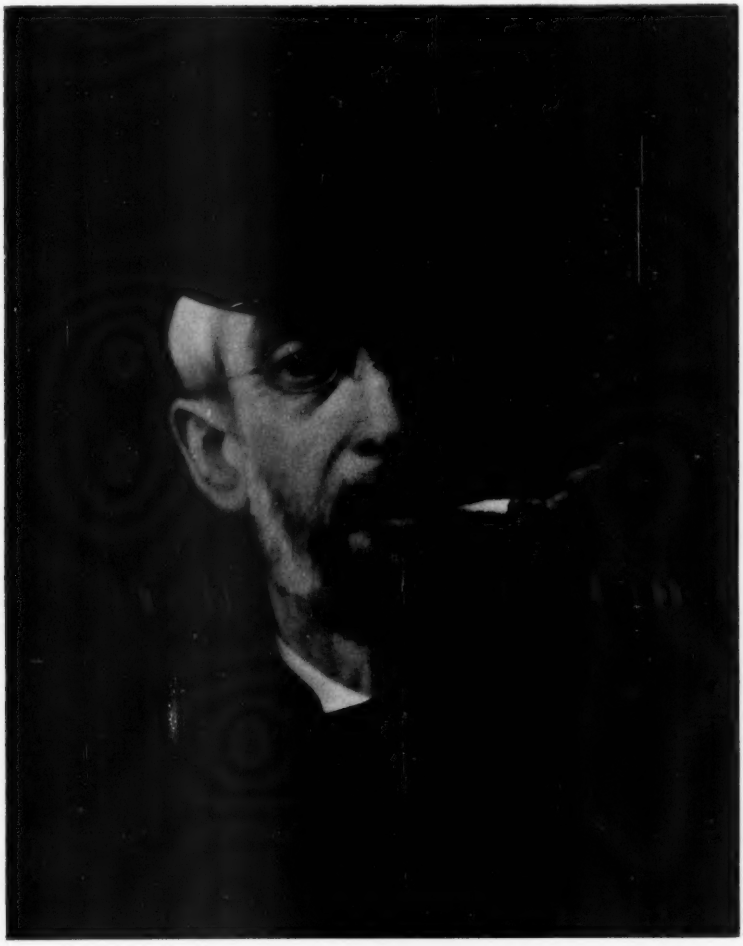
This is the help beyond all others; find out how to make useless people useful and let them earn their money instead of begging it—Ruskin.

"In the nineteenth century the pioneers had been perfecting surgical technique, but no schools of orthopaedic surgery existed; the social workers had by Factory Acts attempted to stem the artificial manufacture of cripples, but the causes of crippling diseases were still unsuspected and unopposed. The century closed with little attempt at prevention, with inadequate accommodation and insufficient treatment in general hospitals, and as the army of cripples was no longer reduced by high mortality, the problem was causing deepening public apprehension. The turn of the tide came in the year 1900. It was then that orthopaedic surgery began to see daylight in the care and cure of crippled children."

Thus wrote Frederick Watson, son-in-law of Robert Jones, in 1930. Twenty years later, as we look back to 1900, the year in which died both William Adams—British pioneer of subcutaneous osteotomy, and Lewis Sayre—one of the pioneers of American orthopaedics, it is difficult to believe that orthopaedics was then no more than a name and an aspiration. The first half of the twentieth century has given to that name both substance and meaning. It has been concerned with the development and organisation of orthopaedics as a social service as well as a technique of surgery. There have been advances and many changes of fashion in the details of operative technique, but there has also been increased recognition of the significance of rehabilitation and resettlement; great strides have been made in the orthopaedic training of doctors, nurses, physiotherapists, gymnasts and occupational therapists; injuries have been segregated under the care of orthopaedic and accident departments; the concept of restoring the function of a limb, rather than producing perfect X-ray pictures of a bone, has remained the ideal of British practice; and there have been closer links with the basic sciences, with greater application of the researches of these sciences to the advance of orthopaedics.

Hardly any other speciality has developed so rapidly or so extensively. Originally and by definition concerned with the straight child, this branch of surgery is now responsible for making people of all ages "straight." Its scope is indicated by the definition of Robert Jones himself: "Orthopaedics is based on, and consists of, the recognition and practice of definite principles of treatment, whether operative, manipulative or educational, which lead to the restoration of function in nerves and muscles, and in deformed or disabled limbs."

The field has expanded steadily as fresh knowledge and new methods of treatment have become available. It is now almost impossible for any one individual to keep pace with the literature, and still less to engage in the practice, of every facet of this branch of surgery; and as experience has matured there has been an increasing tendency to specialise within the speciality, and to concentrate on a single but nearly always complex problem like the surgery of the hand, peripheral nerve injury, intervertebral disc derangement, deformity such as scoliosis, the treatment of chronic arthritis, or the management of injuries.



HUGH OWEN THOMAS (1834–1891).
(Reproduced by permission of the Curator of the National Portrait Gallery).

EARLY DEVELOPMENT

Since 1837, the year in which Queen Victoria ascended the throne, orthopaedics had been practised in Britain by W. J. Little (1810–1894), physician on the staff of the London Hospital, pupil of Stromeyer, and "apostle of tenotomy"; and by Hugh Owen Thomas (1834–1891), who if not the "apostle of rest," as were John Hunter and Hilton, was most certainly its great evangelist. Little and Thomas were founders of the two schools of orthopaedics—the London and the Liverpool. These schools dominated the development of orthopaedics in the early years of the twentieth century; between them there was at first friendly rivalry and, for many years now, the most fruitful and agreeable collaboration.

Hugh Owen Thomas deservedly gained renown, albeit posthumously, as the pioneer of conservative orthopaedic treatment with emphasis upon rest—enforced, uninterrupted and prolonged. He died in 1891, but his influence dominated orthopaedic practice throughout the first half of this century. He was an individualist, ardent and combative, intolerant of the theories and practice of the day, and unafraid of expressing his disapproval both pungently and pugnaciously. With the notable exception of Rushton Parker, professor of surgery in Liverpool, he had few friends in medicine, and his message did not spread as it should have done in his lifetime. But whatever the shortcomings of Thomas may have been they were more than counterbalanced by the activities of his pupil and nephew, Robert Jones. A great humanitarian of outstanding ability, with the personal charm so characteristic of his Celtic origin, completely trustworthy, intensely happy, and always human whether at work or at play, he was ideally suited by experience and temperament to advance the cause of orthopaedics. This task he shouldered and accomplished as much by the force and charm of his personality as by the nature of his message and work. He made the practice of Thomas known throughout the world. As was said by John Ridlon, his old American colleague: "One of the greatest things that Robert Jones ever did was to make the main principles of Hugh Owen Thomas acceptable to the medical profession."

Before he reached the age of thirty the writings of Robert Jones had been translated into French, Spanish and German. With the help of his lifelong friend Thurstan Holland, pioneer of radiology in Liverpool, he shared in producing one of the first radiographs ever made in Britain. He established orthopaedics firmly and securely as a special branch of surgery to such an extent that Sir William Osler wrote in 1917: "There has grown up as a department of surgery the branch known as orthopaedics—the original meaning of which was the straightening of crooked children; but it is now applied widely to the relief of deformities and disabilities of all kinds. All of us really needed this art—some in minds, others in bodies, many in both! In a sense, education is a department of orthopaedics. The orthopaedic surgeon is a teacher, a personal teacher and in two directions—of the patient's mind quite as much as of his muscles and joints. It is not simply a surgical matter, but an individual human problem requiring prolonged attention and study of each case. The new specialists in this branch are as much superior to the half-educated osteopaths and bone-setters as are our ophthalmic surgeons to the old vendors of eye-salves." What a magnificent testimony to Robert Jones himself—his practice, his teaching and his outlook.

THE EVOLUTION OF A PATTERN OR ORGANISATION

Robert Jones had long realised that the crippled child presented a problem that was both surgical and social. As early as 1898 he pronounced that few children were so incurable that they could not recover if placed in proper circumstances; that there should be country hospitals for children suffering from chronic diseases; that each hospital should have an operating theatre; and that "such a hospital should not be regarded as a convalescent institution or be confused with such an institution." The idea was so revolutionary that it aroused opposition. What, it was asked, would happen to the finances of "Homes for Incurables" if more institutions competed for public money? His arguments prevailed.

On April 21, 1900, through the generosity of Liverpool philanthropists, the Royal Liverpool Country Hospital for Children was opened at Heswall. The teachings of Hugh Owen Thomas and Robert Jones, described as the trinity of rest, surgical treatment and fresh air, were at last adopted in their own city.

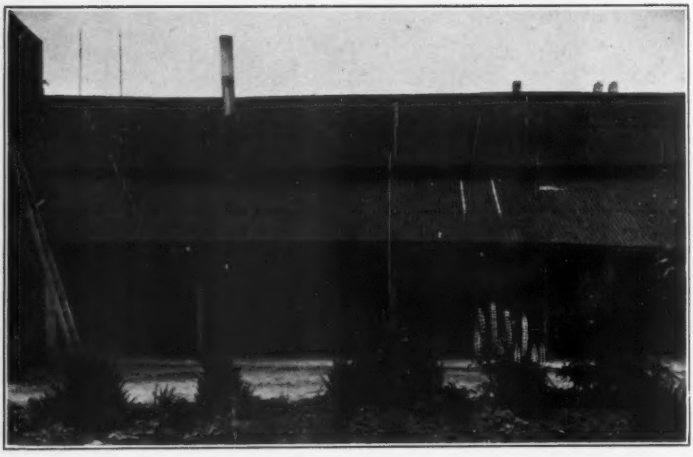
Almost simultaneously, and unsuspected by Robert Jones, the open-air treatment of crippled children was developed with energy and enthusiasm by a dauntless woman in Shropshire—Agnes Hunt. Herself crippled from childhood by suppurative arthritis of the hip joint, she had been impressed at the beginning of her nursing training at the Royal Alexandra Hospital, Rhyl, in 1887, by two important principles in the management of patients

An early photograph of Robert Jones and Agnes Hunt. (Blocks kindly lent by J. Rhaiadr Jones, Esq.)

with chronic illness—open-air and happiness. It is interesting to note that this little hospital, founded by Miss Graham and Miss Vizard who were both trained at the Children's Hospital, Great Ormond Street, London, and perhaps the first institution in Britain to advocate fresh air as part of the treatment of the crippled child, had Hugh Owen Thomas as honorary consulting surgeon.

The story of Agnes Hunt's devotion to the cause of the cripple is well known—the derelict farmhouse and its stables, the primitive drainage, the chronically empty bank account, the four little girls and four little boys who were the first patients—there is no need to recount the story. But the opening of the Baschurch Home in October 1900, some five months after the Heswall centre was established, may be recalled in the words of Agnes Hunt herself: "No splendid vision prompted this open-air hospital, no mighty philanthropic scheme cast its shadow over the humble beginning of the first open-air orthopaedic hospital of the world; no trumpets sounded its advent; no kings, princes or lord mayors rushed to welcome its

The Baschurch Home—the original farmhouse.



The converted hut at Baschurch used as an open-air ward by Agnes Hunt. Probably the first open-air orthopaedic ward in the world.

birth; simply an old and derelict farmhouse in a little old-world village opened its doors and became ' The Baschurch Home.' "

Towards the end of 1904 Agnes Hunt suffered increasing pain in both hip joints and consulted Robert Jones in Liverpool. She records that this was one of the greatest days of her life. A close and enduring friendship sprang up. Both Agnes Hunt and Robert Jones had the same cause at heart; they shared the same temperament; they were gay, inspiring, enthusiastic and human; they were distrustful of sham and disregardful of authority; and they had a sense of the ludicrous. The alliance was indeed formidable. Robert Jones joined the staff at Baschurch in March 1904 and in that year performed the first operation—by candlelight in the dining-room. He attended the hospital regularly almost until the day of his death. No two people did more to advance orthopaedics as a great social service or to develop orthopaedic technique in surgery and nursing. They emphasized the significance of prevention and the early treatment of deformity, the need for prolonged and adequate after-care supervision, and the importance of industrial training and the securing of employment.

Dame Agnes Hunt in the characteristic garb of her own design.

In the fifty years that have passed since October 1900 the Baschurch Home has changed. In 1921 it moved to its present site at Gobowen and, with geographical perversity, was renamed " The Shropshire Orthopaedic Hospital, Oswestry." After the death of Robert Jones in 1933 the name was again changed to the Robert Jones and Agnes Hunt Orthopaedic Hospital. In 1948 much of it was burnt down; but no lives were lost and work was started again within a few days. Rebuilding is now almost complete, and the twentieth-century pattern of an open-air hospital of five hundred beds is evident in the new buildings.

In 1909 the first after-care clinic of the hospital was begun in Shrewsbury, but further extension was not possible until 1917. By then the number of patients readmitted with broken splints and other evidences of neglected treatment was so great that after-care supervision became an economic necessity. Centres were therefore opened in various market towns in Shropshire. At first they were visited each week by an after-care sister who travelled on a second-hand motor cycle! By 1918 there were thirteen centres. To-day there are nearly fifty centres, visited regularly by a team of trained orthopaedic nurses and physiotherapists with a fleet of cars, and at less frequent intervals by surgeons on the staff of the parent hospital. Orthopaedics is thus brought to the patient, and economy is maintained by a remote out-patient system which ensures early recognition, prompt treatment and careful follow-up of orthopaedic disorders. Agnes Hunt lived to see her vision fulfilled, including the establishment in 1928, near the orthopaedic hospital, of the Derwen Training College where 90 per cent of Derwen-trained boys and girls earn their own livings, some in the workshops of the College but most in the open labour market.

The Oswestry example was followed in other country areas, and by 1919 the need for these developments on a national scale was at last realised. There were at least one hundred thousand crippled children in Britain. The advantages of an organised plan were so obvious that a voluntary council, representative of all interested bodies, was founded and presided

over by Robert Jones. This committee for the care of cripples—now a Central Council—advocated a scheme which is worth recording because it still represents the ideal for the needs of most communities. It recommended: 1) a central co-ordinating body working with the Ministries of Health, Education and Labour; 2) local committees for the care of cripples in every district; 3) hospital schools for crippled children with open-air wards where surgical treatment and education could proceed in unison; 4) outpatient or after-care clinics for the examination and treatment of children sent for consultation, supervision of children discharged from the hospital school, and planning of suitable employment for those of more advanced age; 5) invalid schools, both day and residential, for the few children whose disability was

Geographical distribution of orthopaedic prevention and after-care clinics based on the Robert Jones and Agnes Hunt Orthopaedic Hospital, Oswestry.

so great that they could not attend ordinary classes; and 6) surgical wards for the treatment of adolescent and adult cripples who needed orthopaedic treatment.

The Ministries of Health and Education collaborated with the Central Council and encouraged local authorities to develop plans for the education and treatment of crippled children. The co-operation of Medical Officers of Health, School Medical Officers, Tuberculosis Officers, Infant Welfare Centres and County Borough Councils was readily forthcoming. Voluntary local workers, including members of the Red Cross and Order of St John, gave invaluable help in conducting after-care clinics.

It would be impossible to praise too highly the work done since 1919 by the Central Council for the Care of Cripples in conjunction with the Central Council for Infant and Child

Welfare and many other voluntary bodies such as the Invalid Children's Aid Association, the After-Care Association for Physically Defective Children, the National Council for Maternity and Child Welfare, and the After-care Association for Blind, Deaf and Physically Defective Children. They campaigned together against the old idea of central hospitals or special schools which undertook no more than primary surgical treatment without adequate follow-up, and without planning for retraining and re-employment.

Public bodies had been impressed by the Baschurch experiment. By 1917 the Shropshire County Council sent to that hospital all children suffering from skeletal tuberculosis; and in 1918 they accepted responsibility for the care of all crippled children up to the age of fourteen years. This was probably the first public body in the world to acknowledge its responsibility for the crippled child. Other public bodies, encouraged and helped by the Fisher Education Act of 1918, followed the example.

While the pattern was developed in Liverpool and Shropshire there was activity in many other fields—philanthropic, religious and governmental. Women of the calibre of Agnes Hunt were at work. In 1903, Mrs Kimmins and Miss Rennie founded the Heritage Crafts School at Chailey in Sussex—" the public school of crippledom." St Vincent's Surgical Home for Crippled Boys was started in 1907 in a semi-detached house in Clapham under the care of the Sisters of Charity of St Vincent de Paul, at first with the object of educating and teaching trades to incurable and destitute cripple boys of the Roman Catholic religion. As in every other school for physically handicapped children it was soon appreciated that surgical facilities were also needed, and under the guidance of another remarkable woman—Sister Teresa Fraser, together with Robert Jones and McCrae Aitken, a modest beginning soon developed into the present splendid country Orthopaedic Hospital and Training School at Pinner in Middlesex.

In 1908, the same year that the Children's Act was passed by which penalties were imposed on parents who neglected to seek treatment for their disabled offspring, Lord Mayor Treloar's Cripples' Hospital and College were founded at Alton in Hampshire for the treatment of surgical tuberculosis. Sir Henry Gauvain was in charge. This hospital has since extended its scope to include the treatment of all orthopaedic maladies. In 1909 the Royal National Orthopaedic Hospital was opened by King Edward VII on its present site in Great Portland Street, London, representing the amalgamation of three rival metropolitan orthopaedic hospitals—the Royal, the National and the City.

In the two years before the first world war, three hospitals were opened: St Gerards Hospital for children suffering from tuberculous disease at Coleshill, Birmingham; the Liverpool Open-air Hospital for Children at Leasowe; and Queen Mary's Hospital at Carshalton in Surrey. In 1917 the Wingfield Hospital at Headington, near Oxford, became part of the Southern General Military Hospital with a separate orthopaedic unit. By 1920, under the direction of G. R. Girdlestone, an after-care clinic scheme had been organised on the Shropshire pattern in Berkshire, Buckinghamshire and Oxfordshire with the Wingfield as its central hospital. Orthopaedic hospitals for children were, as Agnes Hunt said, " springing up in all directions." The pathos of the crippled child had gripped the imagination of the public. In the 'twenties no fewer than twenty-six hospitals, training schools and after-care clinics were opened—the Ethel Hedley Hospital at Windermere with associated clinics in Cumberland and Westmorland under the aegis of Harry Platt; after-care clinics in Hertfordshire in association with St Bartholomew's and the Royal National Orthopaedic Hospitals; and clinics in Surrey with parent hospitals at St Thomas's and St Nicholas, Pyrford, under the guidance of Rowley Bristow. In 1921 the Royal National Orthopaedic Hospital opened its country branch at Stanmore, Middlesex, in the house of Mary Wardell who in 1882 had given the property for a convalescent home for children of the metropolis recovering from infectious diseases. To-day, vastly extended, this is one of our finest country hospitals and training centres.

Heatherwood Hospital at Ascot was established in 1922 by the United Services Fund to

A notable example of the modern type of open-air orthopaedic hospital in Great Britain. Lord Mayor Treloar's Orthopaedic Hospital at Alton, Hampshire, photographed from the air. (Photograph by Aero Pictorial Ltd.)

A treatment pool at Lord Mayor Treloar's Hospital, Alton.

help the crippled children of ex-service men. In 1924 hospitals were opened at Gosforth, Northumberland; at Brookfield, Hale End, in Essex; and at Coombe Park, Bath. After-care clinics were established in Surrey, Wiltshire, Somerset and Lancashire. A training workshop was added to the Wingfield Hospital. Ivybridge at Plymouth, the Manfield Orthopaedic Hospital at Northampton, and the Kirby Moorside Orthopaedic Hospital in Yorkshire were started in 1925. In the same year the Birmingham Cripples' Union and the Royal Orthopaedic and Spinal Hospital amalgamated to form the Royal Cripples' Hospital, Birmingham, which recently changed its name to the Royal Orthopaedic Hospital. A country orthopaedic hospital was opened at Bretby Hall, Derbyshire, in 1926. In 1927 one of the most attractive of country hospitals, Biddulph Grange, was acquired by the Lancashire County Council for the treatment of non-tuberculous crippled children. The Princess Elizabeth Hospital at Exeter was established in 1928 with clinics in Devon. Through the untiring work of another great

The Great Terrace, Lord Mayor Treloar's Cripples' Training College and Hospital.

pioneer—Dame Georgiana Buller, with Norman Capener, the Devonian orthopaedic scheme is to-day a model of efficiency as a centre of orthopaedic treatment and training of the disabled. Another centre where orthopaedic treatment in hospital is combined with post-operative training of the disabled has recently been completed at Harlow Wood near Nottingham through the efforts of S. A. S. Malkin and the Dowager Duchess of Portland, a life-long patroness of orthopaedics.

The years of economic depression, 1930 and 1931, were lean years for orthopaedic development in this country. Nevertheless the successful outcome of several fresh enterprises was to be seen in 1932. Through the persistent efforts of W. A. Cochrane and others, the Princess Margaret Rose Hospital at Fairmilehead, Edinburgh, was completed for the admission of children. An orthopaedic surgeon was appointed to the Norfolk and Norwich Hospital, and with the Jenny Lind Hospital this has become one of the most active and stimulating centres. Leicester City General Hospital and the Bolton Royal Infirmary appointed orthopaedic surgeons. Mount Gold Hospital at Plymouth, and Standon Hall Hospital at Stafford were established. A large hospital for surgical tuberculosis was opened by the Lancashire Tuberculosis authorities at Wrightington in Lancashire; this and the Black Notley Hospital, Essex, which was opened in 1930, are among the few open-air hospitals in which patients with combined visceral and skeletal tuberculosis can be treated.

The year 1933 opened sadly for orthopaedics with the death of Robert Jones on January 14. Mourned by many thousands of patients, colleagues and friends in all walks of life, his ashes were laid to rest in Liverpool Cathedral, " here to be sheltered so long as these walls shall stand." The greatest orthopaedic surgeon who was at once " a scientist and a humorist in their perfect association " had gone.

In June 1933 the Prince of Wales opened the Wingfield Hospital which had been rebuilt through the generosity of Sir William Morris—later Lord Nuffield. Since then, as the Wingfield-Morris Orthopaedic Hospital, it has played an important part in British orthopaedics under the guidance first of G. R. Girdlestone, later of H. J. Seddon and to-day of J. C. Scott. Its importance as a centre is greatly enhanced by intimate University connections. It is the home of the Nuffield Professor of Orthopaedic Surgery, a chair now held by Professor J. Trueta. In 1934 a Cripples' Training College for London and surrounding districts was started at Leatherhead for men and boys over school age—an institution which continues to do magnificent work.

Between 1935 and 1937, great stimulus was given to the organisation of orthopaedic services by the munificence of Lord Nuffield who made a gift of £125,000 to be used in the cause of cripples. Further gifts of £50,000 and £60,000 were made to the Governments of Australia and New Zealand respectively for the welfare of crippled children in those countries. In 1937 a grant of £150,000 was made for orthopaedic development in Scotland and Northern Ireland. Lord Nuffield specifically wished that part of this gift should provide honoraria to enable young surgeons to specialise in orthopaedic surgery. Later in the same year this great philanthropist gave £100,000 to South Africa for the development of orthopaedic services.

Two important training colleges were opened in 1937—the Stanmore Cripples' Training College under the aegis of the Royal National Orthopaedic Hospital, and the St Loyes Cripple Training Centre at Exeter. It is much to be regretted that the Stanmore Training College has now closed its doors.

During the second world war, from 1939 to 1945, the emphasis of orthopaedic endeavour was on the treatment, rehabilitation and training of war-disabled in both service and civilian life; but at the same time administrative plans of far-reaching importance were developed for adult cripples. The Ministry of Labour and National Service introduced a scheme for the training and resettlement of disabled persons, incorporated in the Disabled Persons (Employment) Act of 1943, which arranged for registration of the disabled, and insisted that every employer should engage not less than 3 per cent of disabled persons on his staff. The recommendations of Sir William Beveridge, the great Liberal leader, in his well-known report of 1942, were incorporated in a number of Acts of Parliament, prominent among which was the National Health Service Act which recognised the right of every person to gain comprehensive facilities for treatment, rehabilitation and restoration of capacity for work, and for State assistance when the disability was so grave as to make it impossible to compete in the open labour market.

ORTHOPAEDIC DEVELOPMENT IN TEACHING HOSPITALS

At St Bartholomew's Hospital an orthopaedic department was established in 1864, directed in turn by Willett, Walsham and Howard Marsh. At the Westminster there was Tubby; at the London, Openshaw; and in the provinces, Robert Jones at the Southern Hospital, Liverpool, and Harry Platt at Ancoats Hospital, Manchester. The hospital status of all these surgeons was that of general surgeon in control of an orthopaedic department, and the first orthopaedic surgeon to be given charge of an orthopaedic department with no responsibility for surgical work outside his speciality was Fairbank, who was appointed to Charing Cross Hospital in 1906. In 1912 Elmslie was appointed to St Bartholomew's, and Trethowan to Guy's. These posts involved the systematic teaching of orthopaedics to undergraduate and postgraduate students.

Gradually, but slowly, orthopaedic units were established elsewhere. To-day, throughout the whole country, there is scarcely a hospital of any size that has not one or more orthopaedic surgeons on its staff. But it is being appreciated more and more that a city hospital, whether teaching or non-teaching, is unsuited for the treatment of chronic illness. The role of these hospitals is to act as " after-care clinics " for the collection, treatment and supervision of out-patients, and with enough in-patient accommodation for investigation, teaching, research and the treatment of " short-stay" problems of disease and injury. It is important therefore that close working liaison should be established between town and country hospitals—a liaison that is being promoted by the regional arrangements of the new National Health Service.

DEVELOPMENTS IN WALES, SCOTLAND AND IRELAND

Wales—Provision for the treatment of skeletal tuberculosis in children and adults was possible from 1921 onwards under the auspices of the King Edward VII Welsh National Memorial Association. Facilities for the non-tuberculous cripple were not well developed until a scheme was developed in South Wales, centred on the Prince of Wales Hospital, Cardiff, which is affiliated to the Welsh National Medical School. The prime movers in this development were Lynn Thomas and Alwyn Smith, with the support of Robert Jones. Caernarvon and Anglesey developed an association with the Liverpool Children's Hospital at Heswall. The other Northern and Central counties established voluntary orthopaedic schemes in 1928, using the Robert Jones and Agnes Hunt Orthopaedic Hospital as their centre, and eleven very active after-care clinics developed quickly. Within recent years orthopaedic surgeons have been appointed at Newport and Swansea.

Scotland—Despite outstanding early contributions to the science and craft of orthopaedic surgery from Edinburgh and Glasgow, orthopaedic development has been slow in Scotland. Cochrane of Edinburgh, stimulated by his work at the Military Hospital at Bangor under Harold Stiles and Robert Jones after World War I, determined to pursue orthopaedics as a career. After working with Goldthwait at the Massachusetts General Hospital he returned to Edinburgh in 1921 and pursued a vigorous, though not always tactful, campaign on behalf of the establishment of the Princess Margaret Rose Children's Hospital at Fairmilehead in 1932, and for the associated chain of after-care clinics in South-East Scotland. Within recent years Walter Mercer has been appointed professor of orthopaedic surgery in the University of Edinburgh, and efforts are being made to co-ordinate the orthopaedic work of the city with the South-Eastern region. The team of orthopaedic surgeons, of which Robert Stirling is a notable figure, has been strengthened recently by the inclusion of Lawson Dick whose work on bone grafting is in the best Scottish tradition.

In Glasgow the greatest credit is due to a general surgeon—James Russell. Seeing the need for orthopaedic development he deliberately took on to his unit at the Victoria Infirmary in the early 'thirties an orthopaedic surgeon, Alexander Miller, and between them they persuaded the Governors of the Victoria Infirmary in 1939 to convert their beautiful Philipshill Country Branch into an orthopaedic hospital to serve the South-West area of Scotland. The Western Infirmary has a flourishing orthopaedic unit under the command of Roland Barnes, with a country annexe at Killearn; and one of the largest fracture clinics in the country has been organised at the Royal Infirmary by James Patrick.

In Dundee, and the neighbouring Bridge-of-Earn Hospital, orthopaedics is being developed by an excellent team headed by Ian Smillie. In Aberdeen, Alexander Mitchell and his pupil Rennie have a healthy organisation with a large country branch at Stracathro. At Inverness there is a fine orthopaedic unit at Raigmore under the care of R. Murray.

Ireland—In 1940 an orthopaedic surgeon was appointed in Belfast and in the same year a chain of clinics was established in most of the important towns of Northern Ireland. There is now a flourishing orthopaedic scheme, centred on Belfast, which engages the time of three

orthopaedic surgeons. Fractures are segregated in the fracture clinic of the Royal Victoria Hospital, and there is an increasing number of " long-stay " beds at Musgrave Park. Credit for the development of orthopaedics in Ulster is due largely to S. T. Irwin—one of the oldest members of the British Orthopaedic Association, and R. J. W. Withers.

In Eire development has been slow. Since the days of R. L. Swan, orthopaedic surgery has been practised by Haughton, de Courcy Wheeler, McAuley, Chance and Sommerville-Large. In 1925 it was thought that " professional pride, a public sense of duty, humanity and patriotism were adding fuel to the fire of beneficient enthusiasm." These were pious hopes expressed with the typical eloquence of the Celt! Nevertheless, within the last two years orthopaedic surgeons have been appointed to Kilkenny and Cork; new country hospitals have been, or will soon be, built; and a combined Northern and Southern Orthopaedic Club is being formed. It is hoped that a service long required by the community will soon be working to capacity.

THE DEVELOPMENT OF ACCIDENT SERVICES

Fractures and dislocations have always received much attention in medical writings but little or no attempt was made to treat them in an organised way until Robert Jones created a fracture service for the workmen who were engaged in constructing the Manchester Ship Canal between 1888 and 1893. Even after this strikingly successful venture, fractures remained the cinderella of general surgery. In 1912 a committee of the British Medical Association investigated the results of treatment in 3,000 fractures; it was found that there was mal-union in 40 per cent, and that even when the anatomical result was good the functional result was often poor. This was the standard of treatment existing in many if not most parts of Great Britain until twenty years ago.

During the first world war Robert Jones proved the value of organised fracture treatment based upon the three principles of segregation of fracture cases, continuity of treatment from the time of injury until full recovery, and unity of control throughout the whole period of treatment. After that war, enthusiastic attention was directed in almost all civilian hospitals to the many problems of medicine and surgery that had perforce been neglected for a number of years—and the need for organised fracture treatment seemed to be less important. For a time the surgical lessons of the war were forgotten. But Platt had already succeeded in persuading his colleagues at Ancoats Hospital in Manchester of the need for segregation of fractures under unified control, and to him belongs the credit of establishing the first hospital fracture clinic in Britain. Within a few years a fracture clinic was developed at the Liverpool Royal Infirmary by Watson-Jones, and similar clinics were soon in action at Leeds, Cardiff and other centres under the direction of orthopaedic surgeons. It was of course a natural and sensible development that fractures should be treated by surgeons trained and experienced in the surgery of bone, joints, muscles and nerves, but much opposition had to be overcome by these pioneers.

In other countries organisations were developed which provoked interest and enthusiasm. In the United States, O'Neill Sherman, chief surgeon to the Carnegie Illinois Steel Trust, after visiting this country during the 1914–18 war, established a comprehensive scheme for the treatment of industrial injuries sustained by employees. It included a series of dressing stations, casualty clearing stations and hospital beds based on the pattern instituted by Robert Jones for the wounded soldier. In 1926 the Vienna Accident Insurance Company established a special hospital in Vienna under the direction of Lorenz Böhler for the treatment of injured workmen.

From 1929 onwards there was energetic activity in Britain initiated by Gwynne Maitland who, as medical superintendent of the Cunard–White Star Line, was fully aware of the disasters that arose from the inefficient treatment of fractures. He inspired Watson-Jones, Griffiths, Platt, Rowley Bristow and others to campaign for the general development of

fracture services throughout the country. A special committee of the British Medical Association was set up under the chairmanship of Henry Souttar to investigate the problem. A comprehensive and convincing report, published in 1935 and based largely on the evidence of Platt's clinic in Manchester and Watson-Jones's clinic in Liverpool, presented so strong a case for the development of organised fracture services that industrial leaders and trade union organisations were stimulated. Their interest was aroused still further at a dinner-party of historic significance, held in the Reform Club, London, when His Majesty the King, then Duke of York, was host to almost every industrial leader of Great Britain. A cinematograph film prepared at the Liverpool Royal Infirmary by Watson-Jones, contrasting old and new methods of fracture treatment and illustrating the principles of rehabilitation, made a powerful impression. In response to the pressure that arose, the Government appointed an interdepartmental committee of the Home Office and Ministry of Health to " inquire into the arrangements at present in operation with a view to restoration of the working capacity of persons injured by accidents, and to report as to what improvements or developments are desirable, and what steps are expedient to give effect thereto." This Delevigne Interdepartmental Committee made unanimous recommendations in its reports of 1937 and 1939 in favour of the institution of special fracture services, and added: " We have little doubt that the principles of the continuity of treatment and after-care until working capacity has been restored should be applied in the accident departments of hospitals to the treatment of all injuries entailing disablement . . . We believe that the results of organised fracture treatment will lead to the adoption of similar measures for dealing with other disabling injuries."

It was then recognised that prolonged disability after accidents arose not only from fractures but also from soft-tissue injuries which occurred with ten times greater frequency. If treated inadequately, as so often they were during the first thirty-five or forty years of the century, these injuries gave rise to serious and protracted disablement. The casualty officers of hospitals, recently qualified medical graduates often working without supervision from senior colleagues, had been asked to accept responsibility for the treatment of a multitude of injuries which in fact called for no less experienced judgment and skill than the treatment of acute abdominal emergencies. It became obvious that comprehensive accident services were needed for the treatment of skin wounds, burns, infections of the hand, tendon and nerve injuries, and indeed all injuries of the locomotor system.

The experiences of the second world war emphasized the need for these services both in military and civilian life. In 1943 the British Orthopaedic Association published a memorandum, prepared by its Fracture and Accident Services Committee under the chairmanship of Watson-Jones, stating the case in detail and advising how such services might be put into effect. And so it has come about that in many hospitals there are now combined orthopaedic and accident departments—a policy which it is hoped will gain universal acceptance.

The Birmingham Accident Hospital is a notable example of the application of these principles. Organised by William Gissane, with the co-operation of the other city hospitals, the municipality, and both sides of industry together with their medical advisers, the hospital was planned for the treatment of all visceral and skeletal injuries including burns. Though housed in a separate building it is part of the Orthopaedic and Accident Services of the Birmingham region. It is a large and highly organised prototype for the less ambitious but essentially similar units needed in all general hospitals throughout the country.

Rehabilitation—It is true that most patients, including children, housewives and sedentary workers who suffer from domestic injuries and are treated in efficient accident departments do not require residential rehabilitation facilities. If good treatment of the injury is combined with good " doctoring " of the patient so that the will to recover is constantly imbued, and morale is sustained by doctor, nurse and physiotherapist, recovery is usually complete within

a few weeks of the time that splints are discarded. Nevertheless there are many patients for whom the gap between the demands of remedial activity in the physiotherapy departments of hospitals, and the stresses of heavy work on the open labour market, should be bridged by a final period of intensified rehabilitation. The aim is to harden the patient through increasing activity of every type, and to concentrate not only on the pursuits of physical activity but also on the inculcation of an attitude of mind—" the will to recover." To some thoughtful doctors who were dealing with industrial injuries it became obvious than many patients were demoralised by long periods of invalidism, and that worry for the present and anxiety for the future were in no way lightened by half-hour visits to a massage department three times each week. Indeed apathy and despair were often induced by such passive treatment.

This had, of course, been recognised by Robert Jones when he established curative workshops in military orthopaedic centres during the first world war. But H. E. Moore was the real pioneer of rehabilitation of injured workmen in this country. In 1925 he began his work at the Railway Rehabilitation Hospital at Crewe. Most of his patients had already received long periods of treatment elsewhere; they were dispirited and seemingly incapable of improvement. Of 165 patients of this type, 115 were returned to their former employment after an average period of seventeen days of rehabilitation by Moore. This was startling indeed, and interest was aroused. That indefatigable worker, Gwynne Maitland, arranged the meeting of such leaders of surgery as Robert Jones, McMurray, Platt, Bristow, Moore, Griffiths and Watson-Jones, together with Robert Hyde of the Industrial Welfare Society and industrial leaders. Slogans were invented—" Getting fit is a whole-time job "; " Rehabilitation starts in the ambulance "; and so on.

Hospitals with well-organised fracture services began to use their gymnasia more and more, and their machines for passive therapy less and less. Patients attended for several hours each day, and meals were provided. Successful out-patient rehabilitation centres of this kind were established in 1938 by H. E. Griffiths at the Albert Dock Hospital, Greenwich; by Miller of Glasgow who concentrated on the social service aspect of rehabilitation and succeeded in rescuing some 80 per cent of injured Lanarkshire miners threatened with permanent incapacity; and by E. A. Nicoll who established a residential rehabilitation centre for miners at Berry Hill Hall, Mansfield. The merit of residential rehabilitation centres was proved beyond doubt in the second world war—as will be discussed in a later section of this review.

It will be generally agreed that rehabilitation has made very real progress in the last two decades. To-day physiotherapists spend as much or more of their training time in hospital wards as in departments of physical medicine. It is part of the training of a physiotherapist to organise class exercises for medical and surgical patients so that the ill-effects of complete and prolonged bed rest are minimised—and to participate with doctors and nurses in the maintenance of morale. It was remarked by a foreign visitor who was observing a ward class with envy: " It is a sight as stimulating for me as it must be for the patients." Active exercise in the gynnasium, rather than passive treatment on the plinth, is the theme of physiotherapy departments.

The miners of Great Britain now have a series of splendid residential centres; and so has one of the military services—the Royal Air Force. Some industries with enlightened surgical guidance have organised workshops for their injured employees, for example, the motor firms Austin and Vauxhall. There are sporadic rehabilitation units throughout the country; there is an adviser in rehabilitation to the Ministry of Health; and one of the Metropolitan Regional Boards has appointed a consultant in rehabilitation. Nonetheless there is still much to be done and it is to be hoped that the lessons of World War II will not be forgotten as quickly or as completely as were those of World War I. We look with confidence to workers in rehabilitation to continue their efforts—Watson-Jones, Harold Balme, Cooksey, Griffiths, Nicoll, O'Malley, Zinovieff, Ling, Kiernander, Mason, Maxwell-Jones, Gissane, Plewes and many others. As the speed of machinery increases, accidents will cause injuries of greater

severity and complexity than ever before. Whatever improvements there may be in methods of treatment, and however great may be the benefits of social security, there will always be need for those whose task is not only to indicate how joints should be mobilised and muscles redeveloped, but also to instil into patients the confidence without which they cannot, because they will not, recover.

HELPFUL LEGISLATION

Throughout the whole of the period under review, constant help was given to the orthopaedic crusade by various Acts of Parliament. The Factory and Workshop Act of 1901 introduced factory inspection and improved hygiene, and it banned many of the practices that had been responsible for injury and disease. The Children's Act of 1908 imposed penalties on parents who neglected to seek treatment for their families. In the years immediately before World War I there were the Trade Board Act of 1909, the Choice of Employment Act of 1910 which allowed grants to after-care committees, and the Lloyd George National Health Insurance Act of 1911 which introduced the panel system whereby wage-earners received general practitioner advice and treatment even if their dependants did not. After the war came the Maternity and Child Welfare Act, and in 1918 the Fisher Education Act which made compulsory the education and treatment of physically defective children of school age. Though it did not come into effect until eight years later it was a signal advance because the liaison created between the Ministries of Health and Education enabled prolonged treatment to be undertaken in hospital without interruption of education. In 1921 the Education Act sanctioned expenditure for the education and training of adult cripples; but national moneys were not yet made available for their treatment. The Public Health (Tuberculosis) Act of 1921 required county councils and boroughs to make adequate arrangements for the treatment of tuberculous patients, including payment for in-patient treatment. After the Milk and Dairies Act was passed in 1922, with insistence on increased cleanliness of milk, there was no further important legislation until the Local Government Act of 1930 altered the old Poor Law and encouraged co-operation between voluntary and municipal hospitals. This helped in extending orthopaedic facilities by the creation of new orthopaedic units in municipal hospitals, working in close harmony with similar units in voluntary hospitals.

The public Health Act of 1936 added further to the responsibilities of county council and borough authorities in respect of the detection and prevention of spread of tuberculosis. The Factories Act of 1937 was a further elaboration of the Factory Act of 1901. Working conditions were improved, hazards were lessened and many devices were introduced by which to reduce the incidence of industrial accidents.

The Workmen's Compensation and allied acts of 1906, 1925, 1931 and 1938, though designed to safeguard the interests of both employee and employer, caused great difficulty to orthopaedic surgeons who were concerned with the restoration of injured men to full working capacity. The two main problems were the " lump sum " settlement and " light " work. A frame of mind conducive to chronic invalidism was often created. As long as compensation was being paid there was little or no organised effort to restore working capacity. Patients and their non-medical advisers often increased the difficulty by refusing treatment lest it might reduce compensation payments. Some workmen were afraid to return to full work because they had no assurance that " cure " was permanent; a few were tempted by the attraction of lump sum settlements and they exaggerated their disabilities; many became chronic invalids, physically and mentally, by reason of the lack of organised rehabilitation, want of appropriate work and failure of sensible reassurance; they lost confidence in themselves and the trouble was aggravated by the insecurity of employment at a time of great industrial depression.

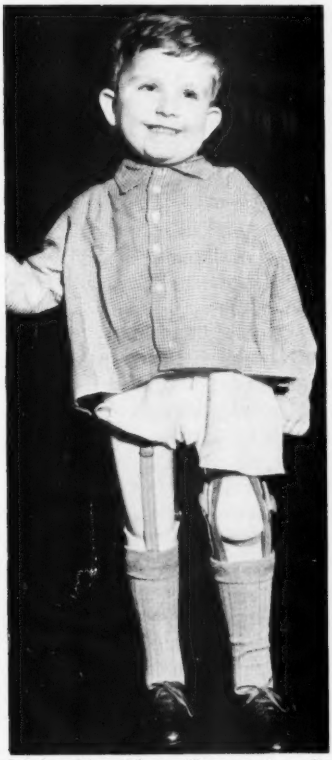
Several Acts of recent years—the Disabled Persons (Employment) Bill (1943), the new Education Act (1945), the National Assistance Act (1948), the National Insurance Act, and

possibly the National Health Service Act (1946), have notably forwarded the cause of orthopaedics. Needless to say, these measures have not been accepted without controversy—in particular the National Health Service Act, which is still regarded by many members of the medical profession as a hostile political intervention tending to regiment the profession, reduce its professional and social standing, and destroy the doctor-patient relationship. It would be foolish, however, to make hasty predictions about legislation which came into force as recently as July 5, 1948. The merit of other Acts of Parliament passed in the last ten years is undoubted. Formerly an injured man was "paid for his incapacity" by weekly compensation or a lump sum settlement, and if he returned to work despite his disability he lost his compensation. To-day the lump sum settlement has been almost completely discarded: a pension, related to the degree of permanent disability, is granted whether the man returns to work or not; and funds are being expended not just to provide a meagre living for the injured workman and his family but also to restore him to health and work. At long last the adult cripple can receive treatment curtailed only, and we hope temporarily, by the shortage of nurses and hospital beds. At long last, artificial limbs and other appliances are available to all who need them. At long last, it is a Government responsibility to train and place in employment those whose injury or disease has made it impossible for them to learn a trade or who are unable to follow their former trade. A young doctor wishing to specialise is no longer prevented from doing so for economic reasons; he earns an adequate income during apprenticeship. Increases of pay have made the indispensable ancillaries of orthopaedics more attractive careers. To state all this is not to imply that the methods devised to secure these advantages have already been perfected—far from it; but it would be a miracle if such radical changes of medical, hospital and welfare services were already perfect. On the contrary, it is perhaps surprising that the transition from voluntary to State control did not produce even greater dislocation. One reason is without doubt the public-spirited attitude of skilled and experienced voluntary workers who despite initial discouragement have continued to offer help and give guidance to the disabled. It is gratifying to find that local authorities are now ready to use established voluntary societies as their agents in advising the disabled on statutory provisions for their welfare. It is even more gratifying that all Ministries are concerned to encourage co-operation with voluntary bodies. All of us who have worked with local voluntary workers in hospitals, after-care clinics or committees know how personal is their contribution to the cripple. The fear that, by its very nature, a bureaucratic machine cannot provide this personal touch makes us hope that democracy will always ensure an economy that allows the spirit of voluntary service to remain a permanent contribution to our civilisation.

TEACHING AND TRAINING IN ORTHOPAEDICS

Undergraduate education—Early in the twentieth century, orthopaedic surgeons contributed to teaching as members of the staff of teaching hospitals. In Liverpool and Manchester, Robert Jones and Harry Platt were quick in developing a university connection as lecturers in orthopaedic surgery. Students attended ward rounds; out-patient sessions and visits to country hospitals were organised; and systematic lectures were given. These activities continue to-day and in most teaching hospitals students have one or more periods of dressership on orthopaedic and accident units. Patients in orthopaedic wards and out-patient departments provide excellent clinical material on which to base the teaching of principles of medicine and surgery, and by which to train students in the elicitation of physical signs. Well organised orthopaedic departments should play an even greater part in the future in training medical students.

In 1937, through the generosity of Lord Nuffield, several new professorships were established in the University of Oxford. G. R. Girdlestone was the first Nuffield Professor in



Congenital deformities of legs. The parents realised that amputations would be inevitable and after five years of continued effort they had saved £200 to provide artificial limbs. But during growth the limbs would have to be renewed, perhaps more than once. Even before the introduction of the National Health Service, funds from charitable sources were often available for the provision of appliances and prostheses. Now, the National Health Service ensures that this happy little boy and others like him will be provided with the very best prostheses whatever their economic circumstances may be. (Permission of Watson-Jones).

orthopaedics, and the first professor of orthopaedic surgery in this country. He was followed in the chair by H. J. Seddon who resigned in 1948 when he became Director of Studies of the Institute of Orthopaedics at the Royal National Orthopaedic Hospital in London. Seddon was succeeded in Oxford by the present holder, J. Trueta. University departments of orthopaedics were established in Liverpool with the late T. P. McMurray as professor; and in Manchester in 1939, where Sir Harry Platt still holds the chair. More recently Walter Mercer has been appointed Professor of Orthopaedic Surgery in Edinburgh University.

For some time it has been obvious that the duties of a professor of general surgery in a university centre can be performed by the surgeon most suited by teaching ability, organising capacity and intellectual stature, regardless of the particular branch of surgery he practises; and this has been recognised in the appointment to the Chair of Surgery of St Thomas's Hospital of George Perkins who has so long served as orthopaedic surgeon to that hospital.

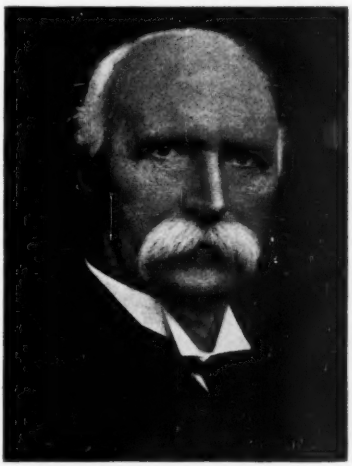
Postgraduate training—Robert Jones gained his training in orthopaedics by apprenticeship with his uncle, Hugh Owen Thomas. Some of his contemporaries in London were self-trained; others studied in continental clinics or were disciples of the group of surgeons who formed the staffs of the Royal, the National and the City orthopaedic hospitals; but the men who emerged as the leaders of orthopaedics were all directly or indirectly pupils of Robert Jones. Many of them worked in intimate relationship with him—T. P. McMurray, his staunchest supporter, assistant and successor at the historic house, 11 Nelson Street; McCrae Aitken; Alwyn Smith; Naughton Dunn; Gathorne Girdlestone. Others were members of the team Jones gathered around him in World War I—Elmslie, Trethowan, Bankart, Laming Evans, Rowley Bristow, Harry Platt, Ollerenshaw and Whitchurch Howell. Many became established after the war in other centres—Birmingham, Oxford, Cardiff, Manchester, London, there to introduce their teachings and often to reproduce their plans of organisation.

Apprenticeship in a first-class orthopaedic unit is still the popular method of training in Britain. In 1943 the British Orthopaedic Association recommended that after completing practical and academic training in general surgery over a period of some three years, and acquiring by examination a Fellowship of one of the Royal Colleges of Surgeons, an additional four years of orthopaedic apprenticeship was essential. A special diploma, the now much coveted Mastership in Orthopaedic Surgery—M.Ch.(Orth.) was established by Liverpool University in 1924 through the efforts of Robert Jones and T. P. McMurray. The course extends over fifteen months and provides comprehensive practical and academic teaching in every aspect of orthopaedic surgery. The standard of knowledge required at the examination by local and external examiners is very high. McMurray devoted an enormous amount of his time, energy, enthusiasm and vivid personal dogmatism to the teaching for this diploma which could then almost be called the McMurray degree. He left an indelible stamp of sound but conservative orthopaedic practice on his pupils who are to-day some of the leaders of orthopaedic surgery in many centres of the British Commonwealth of Nations. In recent years, under the guidance of Bryan McFarland, now Director of Orthopaedic Studies, the training has been extended and broadened. Students must have completed their basic training in general surgery and hold a Fellowship of one of the Royal Colleges of Surgery before beginning the special training in orthopaedics; before examination they must gain knowledge of orthopaedic practice not only in Liverpool but in other centres in Britain; a comprehensive study of the literature of orthopaedics and the basic sciences is demanded; and the academic standards of a University Degree, as opposed to the qualifying standards of a College Diploma, are jealously guarded.

In 1946 the British Postgraduate Medical Federation of the University of London established the Institute of Orthopaedics at the Royal National Orthopaedic Hospital with H. Jackson Burrows as Dean. In 1948 H. J. Seddon was invited to become Director of Studies. The Institute, though still young, is making a powerful impression as a centre of academic and clinical activity and as a training centre.

In 1948 the Joint Committee for Postgraduate Orthopaedic Training was formed under the aegis of the Royal College of Surgeons of England, the Royal College of Surgeons of Edinburgh, the Royal Faculty of Physicians and Surgeons of Glasgow, the British Orthopaedic Association, the Institute of Orthopaedics of the British Postgraduate Medical Federation, and the Department of Orthopaedics of the University of Liverpool. Its committee is representative not only of these bodies but also of every region into which the country is now divided for the purposes of administration under the National Health Service Act. Its purpose is to advise and assist those who seek postgraduate training in orthopaedics, and to recommend suitably sponsored candidates from Britain, the Commonwealth and foreign countries to British training centres. The bureau has been used extensively for these purposes and it is hoped to extend its activities in the future. Britain has all the facilities in its first-class orthopaedic units for providing a complete training in every facet of orthopaedic activity, and the large numbers of requests from all over the world for the use of these facilities underlines the need for a central advisory bureau such as this Joint Committee, working in close harmony with its constituent bodies.*

Since the end of World War II there has been another important development in orthopaedic training. In 1948 a group of thirteen young British orthopaedic surgeons visited many orthopaedic centres in America and Canada and presented papers at the combined meeting in Quebec of the Orthopaedic Associations of America, Canada and Britain. The next year ten American and five Canadian surgeons toured representative clinics in Britain and presented papers at the British Orthopaedic Association Meeting in Nottingham. This interchange was made possible by the generosity of many surgeons in America, Canada and Great Britain and by the help of Lord Nuffield. The value of these visits in establishing friendship and promoting knowledge by observation, exchange of views and critical stimulus can hardly be over-emphasized. Long may they continue.



WILLIAM MACEWEN (1848–1926).

DEVELOPMENT OF THE ART, SCIENCE AND CRAFT OF ORTHOPAEDICS

At the turn of the century orthopaedics had already started to expand as a surgical craft. The " strap and buckle " stage that dated back to the age of Hippocrates was being replaced. Subcutaneous surgery had been practised in Britain since 1837—tenotomy by Little and osteotomy by William Adams. The tremendous discoveries of anaesthesia and antisepsis increased very greatly the scope of surgical activity. In 1877 Lister himself performed an open reduction and wiring of a fractured patella. His pupil, William Macewen, inventor of the osteotome, had by 1880, at the age of thirty-two, established osteotomy as a routine procedure and performed the first bone-grafting operation. His book on growth of bone published in 1912 is one of the orthopaedic classics of this century. Another pupil of Lister,

[* The successful activities of this Joint Committee for Postgraduate Orthopaedic Training have depended almost entirely on the tireless energy of its Executive Officer, Osmond-Clarke, whose great contribution to orthopaedics in Britain during the last fifteen years has been related to his capacity for friendship, understanding and wise guidance of young orthopaedic surgeons—a facility that has been applied faithfully in the work of the Committee which he does week by week at the Royal College of Surgeons of England, Lincoln's Inn Fields, London.—Editor.]

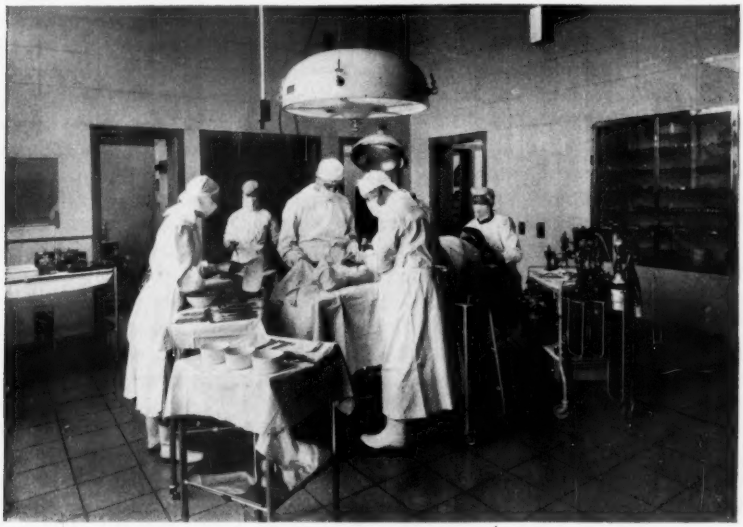
Thomas Annandale of Edinburgh, was also a pioneer of osteotomy and one of the first surgeons to explore the knee joint for a meniscus injury in 1879. He thus opened a field of joint surgery in which, by reason of the frequency of these injuries in Association football, British orthopaedic surgeons became greatly experienced. On January 8, 1894, another remarkable pioneer of bone surgery, Arbuthnot Lane, performed for the first time in Britain open reduction and internal fixation of a fracture of a long bone—an unstable fracture of the lower third of the tibia which he held reduced by two obliquely placed metal screws. His book on *Operative Treatment of Fractures* published in 1905 is another of the ornaments of the period under review.

With these advances in operative technique, and with the conservative principles and methods so firmly established by H. O. Thomas and Robert Jones, the twentieth century opened with considerable promise for continued development—and so it proved. Moreover, advances in other fields—anatomy, physiology, pathology, bacteriology, chemistry, morphology and genetics added much to orthopaedic knowledge and widened its application. It is quite impossible in this review to do more than pay brief tribute to the workers in these fields. Arthur Keith, Wood Jones, Stopford and Arnold Henry are outstanding among our anatomical friends. The discovery of the enzyme phosphatase by the British workers Robison and Kay has probably been one of the greatest single advances in bone physiology since Goodsir's observations on osteogenesis. The work on vitamins by Mellanby, Bourne and others has virtually led to the disappearance of scurvy and rickets. The range of experimental study has been greatly increased by the dramatic work of Honor B. Fell on chick embryo explants. Beevor, Sherrington, A. V. Hill, Fletcher, Hopkins, Adrian and others have made significant contributions to our knowledge of muscle and nerve physiology. Fleming, Florey, Garrod and other bacteriologists have added much to our armamentarium. The British discovery of penicillin has created one of our most powerful aides. The help of pathologists of the calibre of Turnbull, Matthew Stewart and S. L. Baker has been invaluable. Elmslie and Platt made valuable contributions in clinical, pathological and radiographic studies of neoplasms. An early glimpse of the hormonal control of bone growth was given by the work of Dawson and Struthers in 1923. An air of tidiness has at last been given by Elmslie and Fairbank to the bewildering array of bone dystrophies and dysplasias. A promising approach to the solution of problems of congenital anomaly, and familial and hereditary disorder has been made not only in America but by Duraiswami in the Department of Orthopaedic Surgery in the University of Liverpool. His fascinating experiments have demonstrated the noxious effects of substances administered early in the life of the fertilised ovum; and not only has he induced congenital deformities almost at will, but he has shown that once induced by interference with development of the ovum the deformities may thereafter be hereditary and familial.

Since the pioneer days of Thurstan Holland and Robert Jones, X-rays have been of great value in diagnosis and treatment, but we have all learned to recognise the shortcomings of radiographic study which represents no more than the evidence of a structural shadow, and seldom interprets accurately the responses of living tissue except in so far as they are represented by the limited reactions of porosis and sclerosis. Brailsford notwithstanding—radiographic dogmatism is unacceptable. At the same time we are more than ready to acknowledge the contribution made by Barclay in cine-radiographic studies of joint movement, and by Sissons in microradiography.

Antisepsis and asepsis—It was obvious to Arbuthnot Lane that something more than antiseptic technique was necessary if surgical operations were to be safe from the risk of infection. He wrote: " The very moderate cleanliness necessary to obtain a good result in ordinary operations is quite insufficient to meet that required when a large piece of metal, whether steel or silver, is left buried in the wound." Operating theatres had to be improved. Looking at a modern operating theatre—roomy, light and with a minimum of dust-collecting

contents—it is almost impossible to visualise the conditions under which surgeons worked in the early years of the century. We read that at the National Orthopaedic Hospital, London, operations were performed by the whole staff on one morning each week in the out-patient waiting hall which was converted temporarily into an operating theatre. At the Royal Orthopaedic Hospital the house surgeon's sitting-room was used as a theatre each Monday afternoon and, as was recorded by Laming Evans, " the entry of the massive wooden operating table temporarily terminated his tenancy! " By 1900 Lane had already introduced sterile caps, gowns and masks for theatre wear. The object of his aseptic technique was to ensure that a gloved finger never came into contact with the wound or with anything that was introduced into the wound. It was based on the facts that gloves were unreliable and that they would often be perforated if instruments were used forcibly; that powerful antiseptics had an injurious effect on tissues and expecially on bone in which metal was implanted; and that the introduction of infection from outside was a supreme tragedy in bone and joint work.



An operation in progress in a typical operating theatre of modern design.

Swabs and dressings were sterilized in drums; instruments were boiled; all were used dry. The knife used for incising the skin was discarded; the wound edges were shut off with tetra cloths and a fresh knife used to continue the deeper dissection. His instruments had handles of such length that the surgeon's and assistant's hands were distant from the wound. Swabs, ligatures and sutures were held with forceps; needles were similarly threaded and needle-holders used even for skin suture. Drills, screws, plates, and the instruments for holding them, were all kept at boiling point in a small sterilizer. The " active " ends of drills and screw-drivers were returned to the sterilizer after the insertion of each screw. A pupil of Lane and the greatest living exponent of the " no-touch " technique, Sir H. A. Thomas Fairbank, wrote: " Any non-absorbable foreign body to be left in the wound, and every instrument coming into contact with it, were thus guarded from air-borne infection so far as possible." We would all agree with Sir Thomas when he said of Lane: " None of his other pioneer work had a greater influence on the practice of surgery than his no-touch technique."

It very greatly increased the margin of safety with which operations on bones and joints could be performed. In the " abdominal era " of surgery many surgeons failed to realise that periosteum, bone, synovial membrane and articular cartilage were less effective in combating infection than peritoneum. " Bone is filled not with good red marrow but with black ingratitude."

ARBUTHNOT LANE (1856–1943).

In fifty years the technique of Lane has not been bettered. It is a tedious discipline that some have not the patience to acquire, but many of us believe that despite every modern advance of chemotherapy it is still an essential technique in orthopaedic operations if every precaution is to be taken in avoiding the disasters of infection. Occasionally the use of a gloved finger is less traumatic than the use of an instrument; and sometimes it is more accurate to feel than to see; but these rare exceptions do not detract from the virtue of Lane's method which is not an example of " exaggerated asepsis," as one foreign writer described it, but simply a link in the chain of precautions that every well-trained surgeon should use if he is to be confident in the great repertoire of operative measures by which so many disabilities of the locomotor system can now be treated.

The Conservative Approach—In Britain there has always been emphasis on conservative treatment and this tradition has been handed on by nearly all our great teachers. It is easy to acquire skill as an operative technician, and more difficult to gain experience in the traditional conservative methods that are so often more successful—treatment by rest, support and immobilisation, the use of splints, the protection of supporting bandages skilfully applied, and the later more active régime of physiotherapy, occupational and diversional therapy with rehabilitation and vocational training. Even the application of three layers of cotton wool of loose texture, alternating with three layers of domette bandage evenly and firmly applied, as taught by Robert Jones for the protection of a damaged knee, is not always practised, and indeed is sometimes scorned by those whose training has been superficial. The splints devised by Hugh Owen Thomas and Robert Jones—the bed knee-splint, the walking caliper, the spine and hip frames and the posterior spinal support are still essentials in orthopaedic practice. They have survived, as have few other splints. Plaster of Paris is still used extensively although there are signs that it may be replaced in the future by plastic materials. The design of splints is constantly improving. No surgeon has done more than Norman Capener to apply modern principles and, by various spring devices, to support and protect tissues without immobilising them rigidly. His pioneer activity in the modernisation of splints is now supported by a special committee of the British Orthopaedic Association.

Despite the promise of antibiotic and hormonal therapy the time has not yet arrived when tuberculosis, subacute arthritis and rheumatoid affections can be treated without bed rest and immobilisation; and meanwhile increasing attention is being paid to the unfortunate consequences of excessive immobility—hypoproteinaemia and osteoporosis, disturbance of calcium metabolism and renal calculus formation, premature arrest of epiphysial growth, stiffness of joints and wasting of muscles, and the psychological consequences of immobility. The progress of the future depends almost certainly on recognising the validity of former principles of conservative treatment, but applying to them the modifications indicated by the pioneer work of Capener.

Manipulation—The art of manipulation appears to have been the secret of successive generations of bone-setters until Wharton Hood's famous publications in 1871. Robert

Jones used it extensively and successfully, as did all his pupils. He maintained that its object was to stretch or " break down " adhesions which formed in the soft tissues around a joint and caused persistent discomfort after injury, and that it was indicated when there was painful restriction of one of the arcs of movement of a joint. Restriction of all ranges of movement indicated intra-articular damage which was unlikely to be helped by manipulation. There is no magic in the manoeuvres of manipulation; the rationale is to stretch or tear the adhesions by putting the joint through a full range of movement, usually with the patient anaesthetised. It is important that this procedure, like all other forms of passive movement, should never be used in the early stages of joint mobilisation after fracture or dislocation. As Robert Jones pointed out, when discussing the treatment of injuries around the elbow joint in 1912, passive stretching of an irritable joint causes more fibrinous exudate, more adhesions, and eventually a stiffer joint. As Watson-Jones admirably puts it—"the balance between adhesions cured and adhesions produced may be a very delicate one." Manipulation is nowadays used less and less for stiff joints and, instead, reliance is placed on the supervised exercises of the patient. Moreover if, for example, a knee joint is stiff after fracture of the femur and it is decided to manipulate under anaesthesia, no more than about twenty degrees of movement is expected to be regained at any one manipulation. The attempt to regain full movement by forcible manipulation is always followed by reaction so severe that the object is defeated. The role of manipulative treatment is now largely restricted to the painful but mobile joint in which adhesions are so localised that reaction in minimal. Watson-Jones wrote of the paradox that " the stiffer the joint the less valuable is manipulative treatment. The more movable the joint the more valuable is manipulative treatment." The knee joint that is stiff after fracture of the femur, the elbow joint stiff after supracondylar fracture, and the shoulder joint stiff after periarthritis with adhesions, usually respond better to graduated exercise. Only the painful " flat foot," the strained knee, the very early arthritic hip, the recent low back strain, and the shoulder with minimal adhesion formation, respond well to manipulative treatment. Moreover, even in this group of cases, manipulation is now used far less often than formerly. Whereas in the 'twenties and 'thirties it was not uncommon for the orthopaedic surgeon to manipulate half a dozen spines each week for chronic backache, nowadays one manipulation every second or third month is the average for most surgeons.

Deformities—When it is recalled that modern operative technique is so extensive that it cannot be contained fully in a text-book of two volumes with 1,643 pages, and that a short treatise on fractures and joint injuries occupies almost one thousand pages in two volumes, the task of ensuring brevity in recounting the treatment of deformity seems insuperable. Early diagnosis and the increasing co-operation of physicians and surgeons in all branches of medicine, which has been one of the bright features of the last fifty years, has greatly minimised the incidence of acquired deformity from injury, arthritis and poliomyelitis; but there is still very limited prophylactic control of congenital deformity, and such acquired deformities as idiopathic scoliosis remain a challenging mystery. It is still true that the best results of treatment are gained by conservative correction with the support of splints until muscle control is regained and bone configuration restores alignment and stability. This is particularly true of club foot, congenital dislocation of the hip, and knock-knee deformity. Contracted soft tissues may sometimes require division or excision, as, for example, in Fairbank's operation for tight internal rotation of the shoulder in birth palsy, and the operations of Elmslie, Trethowan and Brockman for resistant club foot.

The treatment of congenital dislocation of the hip joint is, of course, based on the pioneer work of the old masters Paci, Lorenz, Putti, Galeazzi and Haglund; but notable contributions have been made by British workers, especially Hey Groves, Laming-Evans, Fairbank and Platt. Simple correction of deformity with splinting in the corrected position does not always lead to the development of normal architecture, and in congenital hip dislocations it is sometimes necessary to stabilise the joint by rotation-osteotomy, the construction of a

postero-superior lip, or by complete reconstruction of the acetabulum. The latter procedure, which is again becoming fashionable, is commonly known in America as the Colonna operation, and in France as the Leveuf operation, but it was, in fact, first described by Hey Groves in 1927, though deepening of the acetabulum had already been performed by Paggi, Hoffa and Lorenz.

McCrae Aitken's thoughtful studies on scoliosis published between 1906 and his retirement in 1948, emphasizing the importance of the postural reflex and breathing exercise in balancing the spine, have never gained the recognition they deserve. There is no doubt that he restored stability to the spines of many patients with scoliosis, and even in this age of turn-buckle jacket correction with surgical fusion of the spine, his work merits reconsideration.

The field of reconstructive surgery needed for the correction of paralytic deformity, initiated by Nicoladone of Innsbruck in 1880, was already well established in this country in early years of the century. In 1899 Robert Jones and Tubby reported fourteen examples of tendon transplantation, and in 1903 they published *Modern Methods in the Surgery of Paralysis*. Tubby was the originator of transplantation of the pronator radii teres for the restoration of supination. One of the best of all these operations is the classical flexor to extensor transplant devised by Robert Jones for irreparable lesions of the musculo-spiral nerve. Harold Stiles, Forrester-Brown and Girdlestone contributed procedures for clawed fingers and clawed toes. Transference of the peroneal and toe tendons to the insertion of the tendo achillis by which to strengthen a weak gastrocnemius and soleus was used extensively by Robert Jones, Elmslie and others.

The segregation of peripheral nerve injuries during World War II provided a fresh spate of material for tendon transference, and by then knowledge of muscle physiology and dynamics had greatly increased. Many beautiful results have been achieved by modifications of old operations, and some new operations have been devised. Hendry, J. P. M. Clark, and Seddon and his co-workers, have been foremost in their contributions. Clark's pectoralis major transplant for biceps paralysis—an operation frequently but wrongly ascribed to the writer of this review—is a particularly valuable addition to our repertoire.

When tendon transference is not applicable, or when it fails to ensure stability and balance, stabilisation of deformed joints is often indicated. This can sometimes be achieved by the bone-block procedures advised by Hendry for the paralysed elbow; but more often surgical fusion of joints is indicated, particularly for example in severe and progressive paralytic scoliosis and in paralytic deformities of the feet. Outstanding contributions to stabilisation of the foot were made by Naughton Dunn, Elmslie and Lambrinudi for equinus and calcaneus deformities, contributions of which we were reminded by the most impressive long-term results presented at the most recent meeting of the British Orthopaedic Association.

When paralysis results in disparity of length in the lower limbs there is to-day a choice of procedures for leg equalisation. The methods favoured in Britain are shoe alterations, temporary epiphyseodesis by Blount's method of stapling, shortening of the sound leg, and lengthening of the short leg. Allan of Birmingham has a remarkable series of splendid results of leg lengthening, using a machine of his own design.

Fractures—The treatment of fractures by closed methods reached a peak of perfection in the hands of Hugh Owen Thomas, Robert Jones and their pupils. The detailed technique of manipulative reduction has recently been described with admirable clarity by John Charnley in his book, *The Closed Treatment of Common Fractures*, which should be read by every surgeon who proposes to treat fractures. In this volume is reaffirmed the principle that scientifically controlled manipulation is still the ideal treatment for the majority of fractures. Despite all advances in operative technique, the sheet anchor of fracture treatment is manipulation.

The use of operative reduction and internal fixation has been stimulated by the discovery of penicillin in London by Fleming and the resulting antibiotic control of infection; by the discovery by Ménégaux and Odiette in France, and later by Venable and Stuck in the United

States, of the significance of electrolysis of metals; and by the work of Arnold K. Henry in Dublin on his intermuscular non-traumatic approaches. In Britain operation is reserved for comminuted fractures of the patella, olecranon and head of the radius, which are often excised, and for unstable fractures of long bones—oblique fractures of one or both forearm bones, oblique fractures of the tibial shaft, most transcervical and some intertrochanteric fractures of the femur. There is an increasing tendency to employ intramedullary nailing in fractures of the upper and mid-shafts of the femur. Credit for the revival of this procedure, which was first described by Hey Groves in 1921, must go to B. H. Burns. He and his colleague R. H. Young are the main British advocates of routine open reduction of fractures of the shafts of long bones. Most surgeons, however, feel that closed and open methods have each their indications and that unless ideal operating conditions are available it is far safer to rely on conservative measures. Current British practice may be said to hold a balance between the two extremes. The virtues of this unbigoted compromise are powerfully advocated in Watson-Jones's *Fractures and Joint Injuries*—already a classic.

In the treatment of non-union, grafting operations have been used widely since the days of Macewen and Lane. Until World War II tibial grafts were used almost exclusively. Failure of the graft to incorporate was high because there was no way of ensuring secure fixation to the host bone. The technique of Albee, ensuring an exact fit, was not always applicable; nor was his superb carpentry within the capacity of many surgeons. Indeed, it is probable that only one British surgeon, W. H. Trethowan of Guy's, was Albee's equal in craftsmanship. Results improved when in 1936 the Americans, Stuck, Venables and Beach, introduced to orthopaedic surgery a metal alloy—vitallium—which did not react with the body tissues. This has been one of the outstanding contributions in this century. In bone grafting, vitallium screws enabled inlay or onlay grafts to be locked securely to the recipient bone. Some of their limitations are becoming obvious, particularly when used in old compound injuries and, as Watson-Jones stressed in his Hunterian Professorship Lecture (1948), it is wise to use as few as possible and not to insert them close to the fracture line. During World War II attention was directed to the use of cancellous bone chiefly by surgeons concerned with reconstruction of the mandible. The work of former advocates of spongiosa bone was reviewed—Ollier, Willis Campbell, Gallie, Matti, Stuck and Ghormley. The claim that cancellous bone chips produced the most rapid and certain new bone formation was substantiated and it was soon observed too that chip transplants were more resistant to infection than cortical grafts. It is nowadays common to use a combination of massive onlay (first described by Hey Groves in 1918) or double onlay tibial grafts, reinforced with chips usually taken from the ilium, in all major reconstructive procedures. It is important to realise that, quick as it is to unite, cancellous bone does not mature any faster than cortical bone and protection must be prolonged.

Intramedullary nailing, combined with bone grafting, has an important role in the treatment of non-union in certain long bones. The internal fixation provided is often sufficient to protect the grafts while allowing active mobilisation of the joints immediately above and below the fracture. Bone banks—for the early work on which we owe so much to the United States of America—promise to lighten markedly the burden of the patient and the surgeon.

Joint abnormalities—Recurrent derangement of joints has been a special British study. It was indeed a Leeds surgeon, William Hey, who in 1784 coined the term "internal derangement of the knee joint." Brodhurst of St George's Hospital was probably the first British surgeon to remove a medial meniscus in 1866. The surgery of the menisci was, however, really established by Annandale of Edinburgh in 1879 and later by H. W. Allingham. The importance of the torn meniscus as a source of disability was appreciated early by Robert Jones who in 1906 published the results of one-hundred successful operations. He was the founder of the modern technique of removal of a meniscus through a limited antero-medial or antero-lateral approach. Derangement of the knee consequent upon stretching and tearing of ligaments has received much attention from British surgeons. Hogarth Pringle, whose

observations on fractures of the tibial spine were remarkably accurate, reported the first repair of the cruciate ligament system in 1907. The cruciate laxity was, however, due to avulsion of the tibial spine which can be reduced readily by manipulation and is by no means the same problem as rupture of the ligament itself. Hey Groves first, and later Alwyn Smith, introduced about 1917 an ingenious operation for the replacement of torn cruciate ligaments by fascia lata. Edwards in 1926 advocated the use of the tendons of the gracilis and the semi-tendinosus instead of fascia lata. These operations have never been wholly successful. The regrettable position is that if intensive development of the thigh muscles with or without a knee cage does not produce sufficient stability, arthrodesis is the only satisfactory procedure. Experiences of ruptures of the lateral ligaments in World War II indicate that immediate repair and adequate immobilisation offer the best chance of a stable joint.

Recurrent subluxation of the ankle has been studied by many British surgeons, notably Elmslie, Watson-Jones and Rowland Hughes. The mechanism is now clearly understood and a reliable operation is available for its treatment. Elmslie replaced the torn external ligament with fascia lata. Watson-Jones's contribution was not so much the use of peroneus brevis as a simpler and more effective repair but the prevention of recurrent dislocation by distinguishing in the acute stage self-reducing dislocations which needed long immobilisation in plaster from simple sprains which needed no special treatment; he showed that the displacement could be demonstrated with accuracy in radiographs taken with the ankle subjected to inversion strain.

The pathogenesis and treatment of habitual dislocation of the shoulder was greatly clarified by Bankart's work. In 1923 he re-emphasized the importance of detachment of the glenoid labrum and advocated for the first time an operation for its reattachment to the bony margin of the glenoid. Curiously enough, the exact pathogenesis, including an account of the defect in the postero-lateral aspect of the humeral head, had been described as long ago as 1837 by Curling, a surgeon of the London Hospital, but his very accurate observations had passed almost unnoticed. The operation advised by Bankart, or that devised by Putti and independently by Platt, are the standard procedures in Britain to-day. Their use affords lasting relief in about 95 per cent of patients.

Platt has aptly christened the prolapsed intervertebral disc " the internal derangement of the spine." Orthopaedic surgeons have realised what perhaps some of their colleagues in allied specialities have not—that once a disc is damaged there is mechanical instability of the spine which may increase with age. Pressure on a nerve root is only an incident, albeit a very painful one, in which not more than about 10 per cent of patients require an operation for its relief. It is important that the damaged intervertebral disc should be regarded as an abnormal joint, comparable to one ankylosed unsoundly by fibrous tissue. If it is treated with care by corseting and some modification of activities the joint may remain painless. If it becomes painful, arthrodesis as for other joints with unsound ankylosis, may be necessary. In Britain most orthopaedic surgeons undertake the whole treatment. A few prefer to tackle it in collaboration with neurosurgical colleagues. Of orthopaedic surgeons, Burns and Young, and more recently Armstrong, have studied intervertebral disc lesions most extensively in this country. No one, however, has yet found a solution for the tragic case of the patient in whom nerve roots become adherent to the site of disc protrusion after its removal. The persistent sciatic discomfort arising from fibrosis in and around such nerve roots is not always cured by lumbo-sacral fusion—at any rate in Britain!

Tuberculous arthritis—It is a sad commentary on an otherwise admirable public health service that orthopaedic surgeons in Britain are still confronted with considerable numbers of patients suffering from skeletal tuberculosis. Our experience is that splinting and bed rest until the disease is quiescent, with later fusion of the affected joint, is still the best we can offer. Orthopaedic surgeons in general, and H. O. Thomas and Robert Jones in particular, deserve great credit for eradicating the disastrous practice of excision of active tuberculous

joints which was nearly always followed by multiple sinus formation and amputation. Amputation for tuberculous disease of the ankle and tarsal joints, performed almost on sight in the first two decades of the century, is now seldom necessary.

There has been a remarkable profusion of techniques for ensuring bony fusion in tuberculous joints. Extra-articular arthrodesis with free grafting of bone is still the most favoured procedure. H. A. Brittain's contributions in the last fifteen years to the technique of arthrodesis have been outstanding, particularly his operation for ischio-femoral fusion. Some have felt it wise to modify his approach but none disputes the soundness of his architectural principles. Streptomycin has been valuable, especially in the healing of sinuses, and there can be little doubt that we are entering a new phase in the treatment of skeletal tuberculosis. We have already found it possible to abort acute tuberculous synovitis, though older lesions in the same patient remain unaffected. The lesson of the moment appears to be that we must establish the diagnosis earlier while the disease is confined to the synovial membrane. This may well mean more joint biopsies which, with the protection of streptomycin, no longer carry the same risk of sinus formation and dissemination of disease. Another advance is the treatment of Pott's paraplegia in selected cases by a modification of costo-transversectomy which allows accurate inspection of the site of disease and evacuation of pus, debris and sequestra. Norman Capener was the first to develop this antero-lateral decompression operation, which he has called lateral rachotomy.

Chronic arthritis—This is an enormous subject which cannot be discussed here in any detail. We should note, however, that the increasingly close liaison between orthopaedic surgeons, physicians and biochemists has ensured that for the past twenty years orthopaedic out-patient departments have ceased to be crowded with sufferers from rheumatoid polyarthritis with quiescent disease but with joints grotesquely deformed. It looks as if the new pituitary and adrenal hormones will make our task easier in the future. In the field of degenerative arthritis there is no such promise. Correction of deformity, redistribution of body-weight, arthrodesis and arthroplasty, make the chronological story of our practice in the operative field. It is interesting to find that an arthroplasty in constant use to-day for the treatment of hallux rigidus and hallux valgus—excision of the base of the proximal phalanx of the great toe—was first performed by N. Davies-Colley of Guy's Hospital on February 13, 1885. In 1904 it was reported by Keller, whose name has since been coupled with the operation. The hip is perhaps the joint most commonly affected by degenerative changes in Britain. It is agreed that when the disease is bilateral arthroplasty is the only justifiable operative procedure. Though the cup arthroplasty of Smith-Petersen is most widely practised there are other methods in use—excision of the head and neck of the femur advocated by Girdlestone and his pupils, and the same operation combined with subtrochanteric osteotomy by Batchelor. The old pseudarthrosis of Robert Jones and Whitman's reconstructive excision of the femoral head extensively used in the 'twenties and 'thirties are no longer popular. Replacement of the femoral head by plastic replicas as advocated by the French surgeon, Judet, is still very much on trial in Britain. For the single hip affected by osteoarthritis controversy still continues about the relative merits of arthrodesis, arthroplasty and displacement osteotomy. It is not proposed to extend the controversy here other than to say that the soundly fused hip is one of the most satisfactory results known, and arthrodesis is still practised widely in this country, particularly by its keenest proponents, Watson-Jones and Brittain.

Hand surgery—Thanks to the work of the Americans, Kanavel, Bunnell, Koch and Mason, disabilities of the hand are at last receiving the attention they deserve. It is a curious fact that surgeons the world over should have been so slow to concentrate on the hand—perhaps the most priceless possession of the human animal. World War II underlined the importance of tendon injuries and burns. R. G. Pulvertaft and R. Furlong have done work of outstanding merit in the repair of damaged tendons, and our colleagues in plastic surgery have done much to salvage the gross mutilations caused by burns.

Tumours—The contributions of Elmslie and Platt to knowledge of bone tumours have been noted already. That outstanding authority on malignant disease, Stanford Cade, has given us the benefit of an unrivalled personal experience of the treatment of bone tumours by surgery and by radioactive substances. In his recent Bradshaw lecture at the Royal College of Surgeons, Platt reminded us that amputation is still the only treatment that can offer a few extra years of comparative comfort to the sufferer from primary malignant disease of bone. In this field radiotherapy has so far been disappointing; it remains to be seen what may be offered by future developments in the science of nuclear fission.

Two British surgeons have made notable contributions in this century to the technique of amputation. The hindquarter amputation so lucidly described, and to this day so ably executed, by Gordon Gordon-Taylor has been responsible for the prolongation of many lives. Within the past few years Brittain and others have diminished the post-operative disability by their success in providing useful prostheses. Forequarter amputation, fortunately even more rarely indicated that the hindquarter, is usually considered a formidable technical feat, as indeed it is through the usual anterior approach. The method described by the Leeds surgeon, Littlewood, in which an initial posterior approach frees the vertebral and upper borders of the scapula and allows the shoulder to fall forwards, thus exposing the great vessels and nerves which can be dealt with easily, seems almost to have escaped attention.

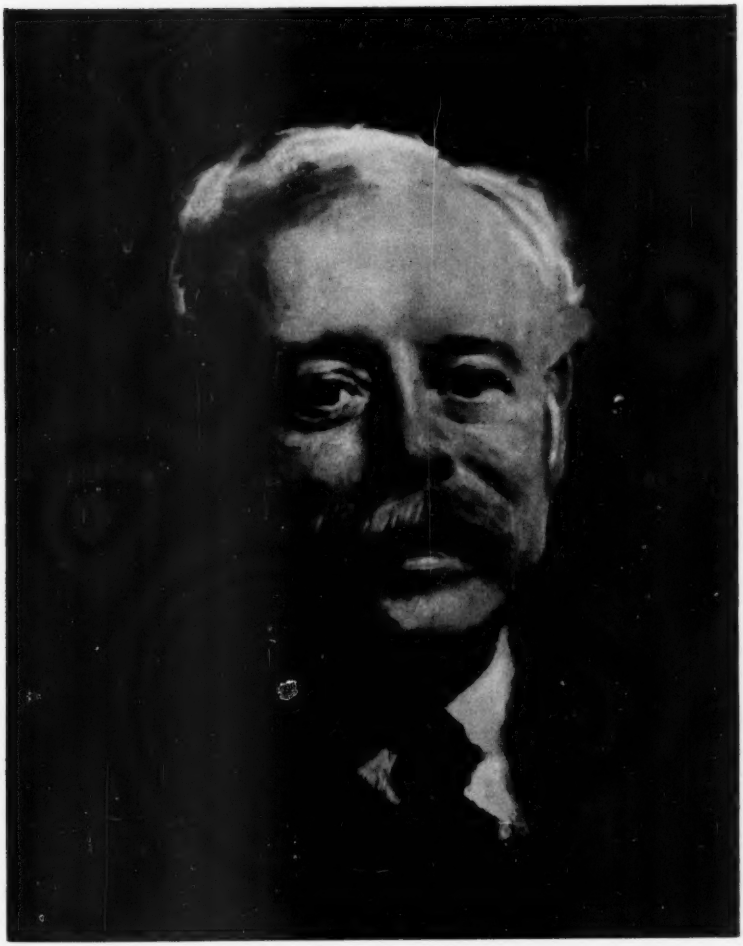
These hasty glances must suffice to indicate current British practice, how it has changed since the early days, and how much we owe to colleagues past and present. The writer was once chided for criticising senior colleagues, for some of whom he had often more affection than respect. He was told: " You young fellows have climbed up on the shoulders of giants." It has indeed been so, and I hope that in this sketchy survey the debt is to some extent acknowledged, though briefly and with a very inadequate pen.

THE LEADERS

Orthopaedic surgery did not develop without nurture from great men and women. Reference has already been made to the predominant efforts of Robert Jones who must be regarded as the pioneer of organised orthopaedic surgery in this country; and to the contribution of Arbuthnot Lane in operative technique. But there were others of commanding stature whose influence was far-reaching.

E. Muirhead Little (1854–1935), youngest son of W. J. Little, the founder of London Orthopaedics, was a contemporary of Robert Jones and a graduate of St George's Hospital. He was the first president of the British Orthopaedic Association and was elected a corresponding member of the American Orthopaedic Association as early as 1894. For practically all his professional life, from 1888 to 1919, he was on the staff of the National Orthopaedic Hospital (later the Royal National Orthopaedic Hospital). When Queen Mary's Hospital was founded at Roehampton during World War I for the limb-fitting of soldiers with amputations, Muirhead Little was surgeon-in-charge until after the armistice when he became a member of the Advisory Council of the Ministry of Pensions and one of the advisers on artificial limbs to the Minister. He was considered in those days to have a greater knowledge of artificial limbs and their fitting than any other living surgeon. His knowledge of orthopaedic literature was encyclopaedic and he himself wrote with erudition and scholarship; much of his writing was, with characteristic modesty, contributed anonymously to the *British Medical Journal*. His most important work was " Artificial Limbs and Amputation Stumps " (1922) and an interesting contribution was his essay on " Orthopaedics before Stromeyer " in the *Robert Jones Birthday Volume* (1928). A man of singular charm and modesty without an enemy, he was, as Rocyn Jones wrote in his obituary, " about the last link with the tenotomy period in the development of orthopaedic surgery."

A. H. Tubby (1863–1930) qualified from Guy's Hospital and after a period of study in Germany he was appointed to the National Orthopaedic Hospital and to the Westminster



ROBERT JONES (1857–1933).
(Reproduced by the kind permission of Lady Probyn Jones).

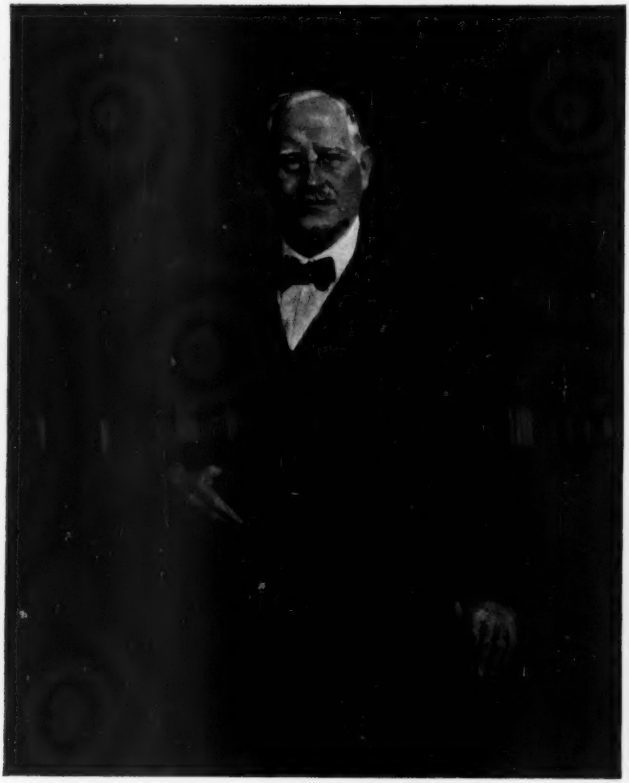
Hospital. Next to Robert Jones he was the outstanding genius of his day in British orthopaedics. A man of great mental and physical activity, he worked extremely hard both at his profession and his pastimes. In 1903 he published in collaboration with Robert Jones a book, *Modern Methods in the Surgery of Paralysis*, advocating the most up-to-date principles of tendon transplantation. But his *magnum opus* was *Deformities: a Treatise on Orthopaedic Surgery*, published in 1906 and demanding a second edition in two volumes in 1912. This book was remarkable for its erudition and in those days for its scope; it dealt not only with deformities but with diseases of joints and especially tuberculosis. It indicated the broadening of the field of orthopaedics which had begun at the turn of the century and which owed so much to Robert Jones and Tubby. This book made Tubby an international figure. He wrote extensively also on sport and archaeology. Indeed, had it not been for his active interest in sport and the demands of an enormous private practice his contribution to the development

A. H. TUBBY (1863–1930).

of orthopaedics might have been greater. He was secretary of the short-lived British Orthopaedic Society and an original member of the British Orthopaedic Association, in the work of which, like his rival Openshaw, he took but little part. In World War I he acted as consultant, mainly in the Mediterranean and Egyptian theatres, from the experience of which he wrote a fascinating and popular little book, *A Consulting Surgeon in the Near East*.

T. H. Openshaw (1856–1929) was one of the great " characters " of his day. " Tommy " to all his colleagues, a Lancashire man by birth, he retained his native accent and abruptness of manner and speech throughout a long life of practice in London on the staff of the London Hospital and the Royal National Orthopaedic Hospital. He was indeed the first surgeon to be in charge of the Orthopaedic Department of the London Hospital. He wrote little and his particular forte lay in the acuteness of his clinical observation and his ability as a forthright teacher. He did not always see eye to eye with his orthopaedic colleagues, either during World War I or after. Though one of the signatories of the circular letter calling a preliminary meeting in 1918 to discuss the formation of the British Orthopaedic Association—the other signatories being Robert Jones and Muirhead Little—he refused subsequently to hold office in the Association and took little or no part in its meetings.

E. Laming Evans (1871–1945) qualified at St Bartholomew's Hospital and took up the speciality of orthopaedics on his return from the South African War. He was for many years



E. W. Hey Groves (1872–1944).

(Reproduced by permission of the *British Journal of Surgery*.)

on the staff first of the Royal and later the Royal National Orthopaedic Hospital. His main interest in orthopaedics was in the manipulative treatment of congenital dislocation of the hip and in the treatment of paralytic calcaneo-cavo-valgus by astragalectomy. Selecting his cases with remarkable care and uncanny judgment he obtained results in these two conditions which can hardly ever have been surpassed. Conscientious to the point of extreme irascibility, he was difficult to please—but there was much to be learnt from him. His devotion to orthopaedics was shown by the bequest to the Royal College of Surgeons of England of the whole of his estate, from which has been founded the Laming Evans Research Fellowship in Orthopaedic Surgery.

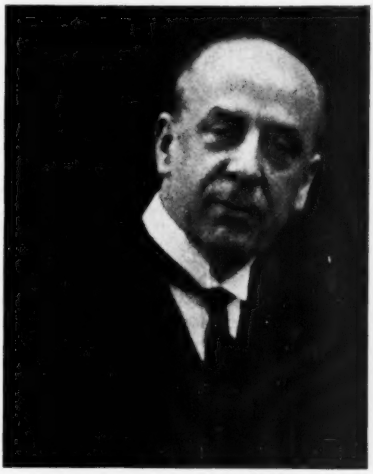
E. W. Hey Groves (1872–1944) qualified from St Bartholomew's Hospital in 1895. After a period as resident accoucheur at his teaching hospital he settled in general practice near Bristol. He gained a considerable local reputation by performing major surgical procedures in his own house, assisted by his wife. These were early signs of an adventurous operative spirit which persisted throughout his life. In spite of his busy practice he had by 1905 obtained

R. C. Elmslie (1878–1940).

his higher degrees and was appointed to the staff of the Bristol General Hospital. Early in his career he turned his attention to bone surgery, and it was in orthopaedics that he established an international reputation. He was a most ingenious surgeon. Many of the procedures now increasingly popular—for example, intramedullary nailing for fractures, acetabular reconstruction for unreduced congenital dislocation of the hip—were first performed by Hey Groves. He was one of the pioneer bone-grafters, using bone, ivory and even walrus tooth! Many of the operations advocated by him required better anti-shock measures than were available in those days and a far stricter aseptic ritual than existed outside Arbuthnot Lane's own practice. He was a prolific writer. Perhaps his greatest contribution to British surgery was the making of the *British Journal of Surgery*, which he founded in 1913 and edited for nearly twenty-five years. As Moynihan said when presenting him with a gift from the editorial committee—"You were one of those in whose mind was conceived the idea of founding in this country a journal worthy of the contributions to the art and science of surgery which England and the British Empire were making. Difficulties were many and opposition and

indifference were found in high places . . . All our plans, all our ambitions, all our efforts, found in you a most willing, most competent and tireless worker. Your industry, your wise judgment, your enthusiasm and unwearying tact have been of value beyond reckoning in maintaining year after year our corporate efforts." The spirit of this eulogy is shared by British orthopaedic surgeons for the help which in many ways and in many places Hey Groves gave to our speciality.

R. C. Elmslie (1878–1940) spent the whole of his professional life as student and surgeon at St Bartholomew's Hospital and at the Royal National Orthopaedic Hospital, except during World War I when he was in charge of the Military Orthopaedic Hospital, Shepherd's Bush. He spent five years as a demonstrator of pathology and his knowledge of this subject coloured his work in orthopaedics. To it we owe the classical work on fibrocystic disease of bones first published in 1914 and expanded subsequently in the *Birthday Volume*. As an orthopaedic surgeon Elmslie was one of the greatest of his day, next only to Robert Jones and perhaps Tubby. His ability to think clearly, his wisdom, imperturbability and admirable judgment were his powerful assets. Indeed the writer has never worked with anyone whose judgment always proved so sound; it seemed that he was incapable of being wrong. He was a competent and neat operator who devised several first-class procedures. His only expressed vanity was to pride himself on sewing skin in, as he put it, " the manner of those who know best how to sew—women." Like Robert Jones, he devoted an enormous amount of time to the social welfare, education and after-care of crippled children. He was in great demand for committee work in his own hospital, Government departments, the Royal College of Surgeons (on the council of which he served from 1933 until his death), the British Orthopaedic Association, the British Medical Association, the Chartered Society of Physiotherapy, and the Central Council for the Care of Cripples. His clear and logical exposition before the Select Committee of the House of Lords is said to have carried the greatest weight in deciding the Committee to reject the osteopaths' claim for recognition. As a man Elmslie lacked the warmth of Robert Jones, whose friend and admirer he always was. He was not easy to know—but his reserve did not prevent him inspiring the greatest enthusiasm and devotion in his pupils which they still retain.



W. H. Trethowan (1882–1934).

W. H. Trethowan (1882–1934) was a student of Guy's Hospital and was appointed its first orthopaedic surgeon in 1912. He was one of Robert Jones's team at Shepherd's Bush in World War I. After the war he joined the staffs of the Royal National Orthopaedic Hospital and Queen Mary's Hospital for Children, Carshalton, and quickly established one of the largest private practices in London. He was a genius; but unfortunately he seldom committed his ideas to print. Indeed, his only writings were " The Treatment of Simple Fractures " in Robert Jones's *Text-book of Military Orthopaedic Surgery* in 1920 and an article of singular clarity and brevity on orthopaedics in Choyce's *System of Surgery*. It was his custom to make full notes and to write long explanatory letters to doctors. Fortunately, a selection of these letters expressing Trethowan's views on topical orthopaedic conditions (foot anomalies, abnormalities of the back, disorders of the knee and bone grafting) have been published in book form by his associates, Lambrinudi and Stamm. Reading these is almost to hear the

fervent advocacy or condemnation all over again. It is to be hoped that this remarkably fine little book, containing the views of one of the greatest, if not always the soundest, of teachers will be reproduced. One recalls his out-patient sessions: there was never a dull moment. His imitations of gaits in various orthopaedic conditions can never be forgotten by any who had the good fortune to be present. He maintained that the object of orthopaedic surgery could be written on a thumbnail—function. As an operator he has never been equalled. Indeed, a house surgeon of his once said: " I would insist on Treth (as he was known to all) doing my operation if Elmslie decided that an operation was necessary." A disciple of Arbuthnot Lane, he quickly mastered the no-touch technique and applied it to every operation, great and small. His incisions were long, to enable him to see before he cut and to make it unnecessary to use the sense of touch. He never ligated vessels, maintaining that if a surgeon exposed bone at its most superficial point and stayed close to bone he was unlikely to cut any vessels of importance. Bone-grafting was perhaps his special forte. He favoured long intramedullary insertion of the graft at one end and a mortise fit to the circumference of the bone at the other. In the writer's judgment he was a greater technician in this field than Albee, who was not embarrassed by adherence to a no-touch technique!

At conferences he often favoured the dramatic touch. Few will ever forget seeing him during a discussion, probably on foot deformities, spring to his feet brandishing a Thomas's wrench and exclaiming, " This is a barbarous weapon!" as he threw it to the floor. His good friend Robert Jones was not perturbed and let the remark pass with a kindly smile. Trethowan was a generous friend and a remarkable host. No one enjoyed a party more and he was always the last to leave. Many will recall parties at his Hampstead home where in the billiard room he had installed an enormous organ. An able performer, he would begin to play perhaps at midnight and continue fortissimo well into the early hours of the morning. He was a great figure, a most stimulating chief, and a good friend.

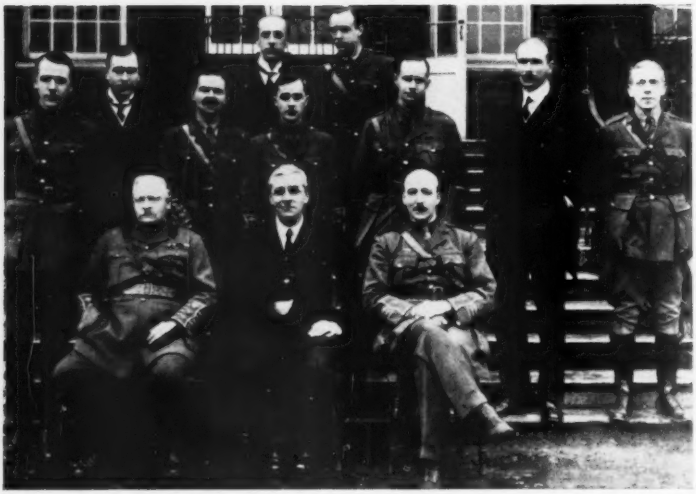
Naughton Dunn (1884–1939), a graduate of Aberdeen University in 1909, became in the following year house surgeon to Robert Jones in Liverpool. Thus began his career in orthopaedic surgery and a friendship that lasted until Jones died. He worked at Number 11 Nelson Street as a private assistant until, on the recommendation of Jones, he was appointed in 1913 to the Birmingham Cripples' Union—now the Royal Orthopaedic Hospital, Birmingham. In the 1914–18 war Dunn worked first at Shepherd's Bush and later at a military orthopaedic centre in Birmingham. His association with Robert Jones and Agnes Hunt—he was also on the staff of the Robert Jones and Agnes Hunt Orthopaedic Hospital—had given him the training and the knowledge to develop orthopaedic schemes in the Midlands. He did this well, for he was a shrewd and competent organiser. In time he became Lecturer in Orthopaedic Surgery in the University of Birmingham. His main contribution to the craft of orthopaedic surgery was his work on the operative treatment of paralytic deformities of the foot. He was a man of striking appearance with white hair, his strong features relieved by a friendly smile, and his perpetual cigarette. As a host he was genial and friendly to juniors and seniors alike but his good humour did not always survive the strains of the operating theatre! In some respects he was an exacting taskmaster. But the evening always found him at his best and never more so than when entertaining at the Boot Inn, an ancient hostelry close to the Robert Jones and Agnes Hunt Orthopaedic Hospital. Some of us were privileged to be his guests as officers of the British Orthopaedic Association when he was president just before the outbreak of World War II. Few will forget the friendliness and charm of the man in his own beautiful home where he entertained us. He died in office a few months after war was declared.

Constantine Lambrinudi (1890–1943) of Guy's Hospital died at the age of fifty-three. British orthopaedics lost too early one of its most brilliant thinkers. For long he had been overshadowed by his volatile, exuberant senior colleague, Trethowan. Within a few months of the latter's death, Lambrinudi was stricken with his first attack of coronary thrombosis,

C. LAMBRINUDI (1890–1943).

but he lived as normal a life as he could until he died. He was at heart a physiologist immensely interested in errors of posture and function, their cause, and how to correct them. He appreciated, perhaps even more than most orthopaedic surgeons, that operations were only incidents in the restoration of function. It is not surprising that the procedures he has bequeathed us have the merit of simplicity and have stood the test of time—interphalangeal arthrodesis for claw toes and cavus feet; and a particular pattern of subastragaloid mid-tarsal arthrodesis for drop foot and for talipes calcaneo-cavo-valgus. One of his most thoughtful essays on the mechanism of carpal scaphoid fractures published in the Guy's Hospital report is far too little known. His attractive appearance confirmed his Greek parentage. His progressive thought on many topics outside orthopaedic surgery, his nimble intellect, his sense of humour, and his unfailing charm and courtesy, made him one of the most engaging and stimulating companions in British orthopaedic circles.

Walter Rowley Bristow (1883–1947) was trained at St Thomas's Hospital and was the architect of the orthopaedic department of that hospital. His interest in orthopaedic surgery began in 1916 when he was appointed surgeon at the Military Hospital at Shepherd's Bush. At first chiefly interested in electro-therapeutics he came under the influence of Robert Jones and from then onwards devoted himself to orthopaedics. After World War I an orthopaedic department was established at St Thomas's Hospital with Robert Jones as its titular head and Bristow his assistant. In fact, Bristow was the director, and the combination of Bristow



Many of the original members of the British Orthopaedic Association photographed in 1918 outside Queen Mary's Auxiliary Convalescent Hospital, Roehampton, London. *Sitting (left to right)*—Openshaw, Muirhead Little (President), Bennett. *First row*—McMurray, Blundell Bankart, McCrae Aitken, Harry Platt, Elmslie, Laming Evans, Naughton Dunn. *Back row*—Trethowan, Rowley Bristow.

TREASURER'S REPORT OF RECEIPTS AND EXPENSES, MAY-AUGUST, 1918.

Cr.	£	s.	d.	*Dr.*	£	s.	d.
By Subscriptions	69	6	0	By Stationery	0	5	7
				„ Printing	1	3	6
				„ Stamps	0	2	11
				„ Cheque Book	0	2	6
				„ Capt. Platt	8	5	9
				„ Balance	59	5	9
	£69	6	0		£69	6	0

Audited and found correct,

(Signed) D. McAITKEN.
NAUGHTON DUNN.

E. MUIRHEAD LITTLE,
July 28th, 1918.

W. EDWARD BENNETT,
Treasurer.

The first balance sheet of the British Orthopaedic Association. Small beginnings indeed!

and Perkins was to become one of the most formidable in British orthopaedics. The county hospital at Pyrford—now the Rowley Bristow Orthopaedic Hospital—to which he was soon appointed, formed an admirable country hospital annexe for long-stay orthopaedic patients. He was never a prolific reader or writer but his contributions on internal derangement of the knee and on peripheral nerve injuries were of value. Though an exceedingly shrewd orthopaedic surgeon his real forte lay in his supreme ability to handle patients with sound common-sense psychology—in a word, he was a great, a very great, doctor. In World War II he occupied the post of his old chief and friend, Robert Jones—consultant in orthopaedic surgery to the British Army with the rank of brigadier. A good mixer, he carried through this enormous task with conspicuous success. His many friends regret that this, perhaps his greatest contribution to British orthopaedics, received no official recognition. As a man Bristow was, like Robert Jones and Trethowan, a most colourful personality. He worked prodigiously hard and enjoyed himself with equal verve. He was an epicure of food and wine and without doubt one of the finest hosts in London. The writer saw much of " Rowley " in the years of World War II. It is a pleasure to have the opportunity to acknowledge publicly a great debt to this warm-hearted man for wise counsel, help and hospitality.

T. P. McMurray (1888–1949) was more intimately connected with Robert Jones's professional life than any other, though as individuals the contrast could hardly have been greater. McMurray was an Ulsterman and he retained the unmistakable characteristics of speech, thought and conduct all his life. He was first a house surgeon and subsequently Robert Jones's private assistant. They worked in unison at Number 11 Nelson Street until Jones died. McMurray remained at this famous home of orthopaedics until it was destroyed by a bomb in World War II. In the first war McMurray worked chiefly at the military orthopaedic centre at Alder Hey on the outskirts of Liverpool. He was steeped in the teachings of Thomas and Robert Jones and he remained a rigid advocate of their methods and a sceptic about most others all his days. He was sound in judgment, a dexterous operator and a fine teacher. He devoted himself, with Robert Jones and after the latter's death, to establishing orthopaedics in its proper place in academic circles in the University of Liverpool. Under his influence a university department of orthopaedic surgery was founded and in 1938 McMurray was appointed Professor of Orthopaedics. The Mastership of Surgery degree in orthopaedics (M.Ch.Orth.) was his life-long interest. He carried most of the enormous burden of teaching for this degree himself. It can truly be said that when a candidate acquired the M.Ch.Orth. he was certain to be a sound conservative orthopaedic surgeon. The British Commonwealth of Nations is fortunate in being well supplied with men of this calibre who remain devoted disciples of McMurray. In October 1948 they came from far and near to honour him by presenting on the occasion of his retirement a leather-bound volume inscribed on vellum which embodied the signatures and portraits of men who have passed through the Liverpool school of orthopaedic surgery during the last twenty-five years. He will be remembered for his work on knee-joint injuries, his displacement osteotomy for ununited fractures of the femoral neck and for osteoarthritis, and for his orthopaedic text-book which will remain as a record of all that was so good in the teachings of a great Liverpool triumvirate—Hugh Owen Thomas, Robert Jones and T. P. McMurray.

Space does not permit a detailed account of all who have helped to build the edifice of British orthopaedics: Jackson Clarke, W. E. Bennett, Lynn Thomas and Alwyn Smith who did so much for the development of orthopaedics in South Wales; Henry Gauvain, the genial founder of Alton; Ollerenshaw of Manchester; William Cochrane of Edinburgh; Mitchell Smith of Stoke and others. The debt is heavy, too, to senior colleagues who are happily still amongst us—Fairbank, McCrae Aitken, Bankart, Girdlestone, Platt, Rocyn Jones, Forrester-Brown, Whitchurch Howell, Alan Todd, Buxton, Perkins, Alexander Mitchell, James Russell, S. T. Irwin, Wilson Stuart, S. F. H. Haughton. Of all it may well be said that they hoarded neither gifts nor strength in the service of British orthopaedic surgery.

BRITISH ORTHOPÆDIC ASSOCIATION.

Office Bearers for 1918 and 1919.

President:
E. Muirhead Little.

Vice-President:
Sir Robert Jones, C.B.

Honorary Treasurer:
W. E. Bennett.

Honorary Secretary.
Harry Platt.

Executive Committee:
A. S. B. Bankart. D. M. Aitken.
T. P. McMurray.

Nomination Committee:
A. S. B. Bankart. H. A. T. Fairbank.
R. C. Elmslie. Sir Robert Jones, C.B.
A. H. Tubby, C.B.

Publication Committee:
T. R. W. Armour. R. C. Elmslie
W. H. Trethowan.

Official Organ (in conjunction with the American Orthopædic Association), "The Journal of Orthopædic Surgery," published monthly.

American Editor: Mark H. Rogers.
British Editor: R. C. Elmslie.

The first office-bearers of the British Orthopaedic Association. Reprinted from the 1918 Report.

ORTHOPAEDIC SOCIETIES

The British Orthopaedic Society was the first of its kind in Britain. Its first meeting was held in 1894, when A. H. Tubby of London and Luke Freer of Birmingham were appointed secretaries. It did not last long; its last meeting was held at the Westminster Hospital on December 9, 1898. Fifteen years were to pass before in 1913 orthopaedic surgeons succeeded in promoting a new venture. After some negotiation the Section of Surgery of the Royal Society of Medicine consented to the formation of a sub-section of Orthopaedic Surgery. The council of this sub-section met on July 8 with Muirhead Little as president and Blundell Bankart and Rock Carling as secretaries. Several members of the defunct British Orthopaedic Society were members of the council—Muirhead Little, Robert Jones, Tubby, Jackson Clarke and Openshaw. Orthopaedics in general and the new orthopaedic sub-section in particular received a great stimulus from the meeting in London, in August 1913, of the International Congress of Medicine. Orthopaedic surgeons from Europe and America came in impressive numbers to its orthopaedic section, presided over by Robert Jones. Arthur Rocyn Jones, our outstanding historian and biographer, reminds us of the wide range of subjects discussed, and the stature of the openers of the discussions; club foot by Lucas Championiere and Whitman; scoliosis by Lovett and Schanz; spastic paraplegia by Kuttner, Muirhead Little and Vulpius; the treatment of ankylosis by Baer and Putti; the treatment of tuberculosis of joints by Dollinger, Ridlon and Rollier; and, breaking new ground, Fred Albee reporting " Original uses of the Bone Graft as a treatment for Ununited Fracture, certain Deformities and Pott's Disease," based on an experience of 175 cases.

This important meeting, so propitious in its timing, gave British orthopaedics such prestige that the orthopaedic sub-section of the Royal Society of Medicine could hardly fail; and it did not. Though its meetings were suspended during the war years they were resumed in the autumn of 1919. By then the body was sufficiently powerful and successful to petition for the formation of a full section. The petition was presented with singular tact, defining orthopaedics as " the surgery of congenital and acquired deformities of the extremities and spine." There was nothing in this to arouse suspicion or increase hostility from general surgeon colleagues of the section of surgery. Accordingly, a section of orthopaedics was constituted and held its first meeting on February 7, 1922, with T. H. Openshaw as its president. Since then the section has flourished, and it plays an important and very active role in providing a forum for discussion and debate and for the presentation of difficult and interesting clinical problems, all of which are reported monthly in the *Proceedings of the Royal Society of Medicine*. Fellowship of the Society allows attendance at the meetings of all sections and makes available one of the finest medical libraries in the world. Happily, arrangements can be made which allow visiting foreign surgeons access to the meetings and to the library.

In 1918, at the instigation of Robert Jones, Muirhead Little and Openshaw, the British Orthopaedic Association was founded with Muirhead Little as president, Harry Platt as secretary and W. E. Bennett as treasurer. Unlike its predecessor, the British Orthopaedic Society, the Association survived and has grown in authority and in membership, uninterrupted by World War II. At first there were twenty-one members; to-day there are 513 fellows and members. This increase in numbers, though inevitable with the growth of this branch of medicine, is a mixed blessing, for the two meetings each year have become overcrowded. There is too little informal discussion and it is almost impossible for the Association to travel abroad *en famille*—a pleasant feature of the early 'thirties, when spring visits were made to Mürk Jansen at Leiden, to Paul Guildal at Copenhagen, to Haglund and Waldenström at Stockholm and to Jacques Calvé and Marcel Galland at Berck.

The Association has changed its function with the years. At first it concerned itself only with the scientific and clinical aspects of orthopaedics, meeting twice a year in the spring and

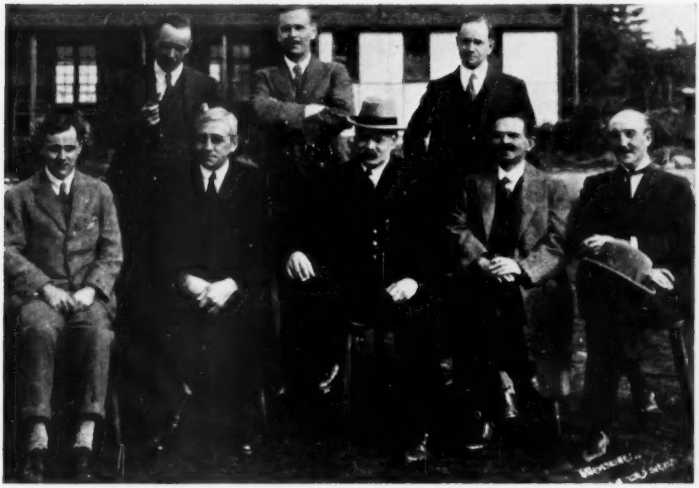
MEETINGS IN 1918.

INAUGURAL MEETING FEBRUARY 2ND, 1918.

The British Orthopædic Association was formally constituted at a meeting held on Feb. 2nd, 1918, at Queen Mary's Auxiliary Convalescent Hospital, Roehampton House, London, S.W. Mr. E. Muirhead Little acted as Chairman, and put to the meeting the following resolution: "That this meeting declares that a Society to be called the British Orthopædic Association is hereby constituted, and that the following surgeons be the original members thereof—D. M. Aitken, T. R. W. Armour, A. S. B. Bankart, W. R. Bristow, J. Jackson Clarke, Naughton Dunn, R. C. Elmslie, E. Laming Evans, H. A. T. Fairbank, Sir Robert Jones, W. S. Haughton, E. Muirhead Little, T. P. McMurray, T. H. Openshaw, Harry Platt, W. H. Trethowan, A. H. Tubby." Of these members all were present at the meeting with the exception of Messrs. Armour, Jackson Clarke, Fairbank, Sir Robert Jones, Haughton and Tubby. Major R. B. Osgood, of Boston, U.S.A., who had helped very considerably in the preliminary steps which had led to the formation of the Association was present as a specially invited guest.

A Constitution and Bye-laws which had been drawn up in anticipation of the meeting was adopted and officers elected for the years 1918-1919. In accordance with the provisions of the Constitution, certain distinguished surgeons in the British Isles and abroad were elected as honorary and corresponding members. The executive proceedings concluded after the President had chosen the members of the three committees, Executive, Nomination and Editorial.

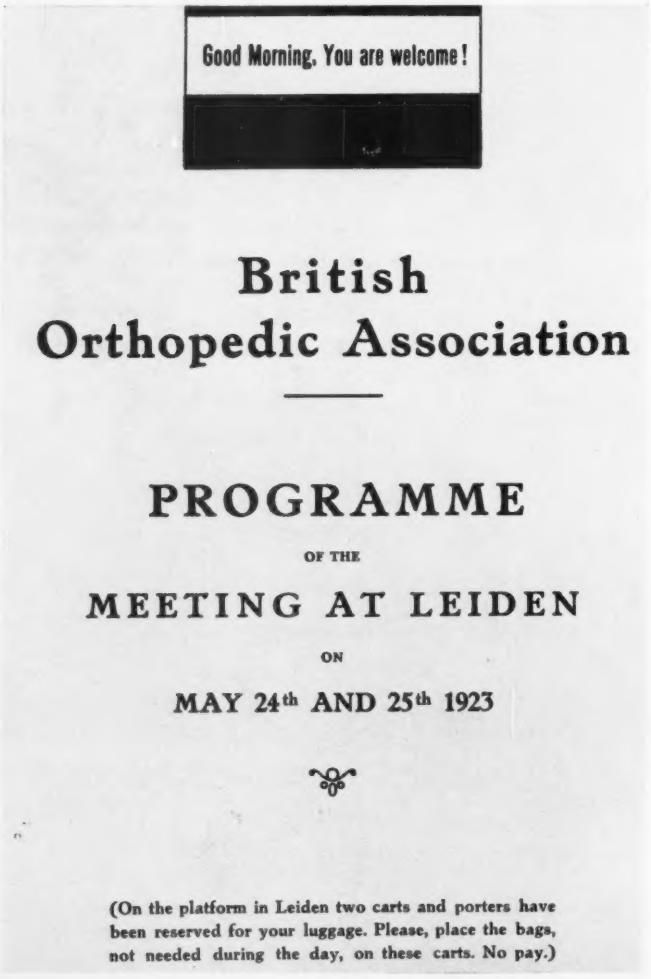
Extract from the first annual report of the British Orthopaedic Association.



A photograph of office-bearers of the British Orthopaedic Association in 1921. *Sitting (left to right)*—Harry Platt (Secretary), Muirhead Little (President), Robert Jones (Vice-President), McCrae Aitken, W. E. Bennett (Treasurer). *Standing*—Rowley Bristow, Girdlestone, Elmslie.

A meeting of the British Orthopaedic Association at Oswestry in 1921. *Front row (left to right)*—Naughton Dunn, Lynn Thomas, Gauvain, Muirhead Little, Robert Jones, Agnes Hunt, McCrae Aitken, Hey Groves, Harry Platt. *Second row*—Mumford, Bankart, Bristow, Haughton, Verrall, Fairbank, Thurstan Holland, Mennell, Elmslie, Murray-Levick, Noble, Somerville, Bennett. *Third row*—McPhee, Russell, A. N. Other, A. N. Other, Whitchurch Howell, Mitchell Smith, Percival Mills, Barclay, Woodburn-Morrison, Colonel Thresher, Hough. *Top row*—Trethowan, Rocyn Jones, Girdlestone, A. N. Other, Brentnall.

Visitors arriving in Holland. *Left to right*—Rowley Bristow, Miss Forrester-Brown, a guest, McCrae Aitken, Mrs Elmslie, Robert Jones, Harry Platt were received with the courtesy typical of Mürk Jansen, so well illustrated in the programme cover that is shown below.


Good Morning, You are welcome!
British
Orthopedic Association
PROGRAMME
OF THE
MEETING AT LEIDEN
ON
MAY 24th AND 25th 1923
(On the platform in Leiden two carts and porters have been reserved for your luggage. Please, place the bags, not needed during the day, on these carts. No pay.)

autumn for this purpose. Inevitably it has had to exert its influence in medical politics as well—another mixed blessing!

The first combined meeting of the American and British Orthopaedic Associations was held in London in 1929. It was an enormous success, occurring in days when there were no currency restrictions. In 1948 a second combined meeting took place in Quebec, joined on this occasion by the Canadian Orthopaedic Association. The meeting was conducted by R. I. Harris, president of the American Orthopaedic Association; Edouard Samson, president of the Canadian Orthopaedic Association; and Alan Malkin, president of the British Orthopaedic Association. This was an historic occasion and an outstanding event in the development of orthopaedics in Britain and the North American continent. It is hoped that similar meetings can be arranged at regular intervals in the future.

Repeated efforts had been made to found an International Society of Orthopaedic Surgery. Informal talks had taken place in London between Lovett, Robert Jones and Putti at the time of the meeting of the International Society of Medicine in 1913, and rules were drawn up. Because of the outbreak of war in 1914 the project was abandoned. It was discussed again in 1921 when Jones, Putti and Platt were guests of Lovett in Boston, but again postponed because of the still strained relations with Germany. However in 1929 at the combined meeting of the American and British Orthopaedic Associations in London, Robert Jones, Putti and Albee explored the ground again. In October 1929 a group of international surgeons met in Paris, founded the Society and elected Robert Jones as its first president. There are some fifty British members who are keenly interested in this Society, which has such an enormous potential for the promotion of international knowledge, friendships and goodwill. British orthopaedic surgeons are proud that another of its most distinguished figures, Sir Harry Platt, was elected to the presidency in 1948.

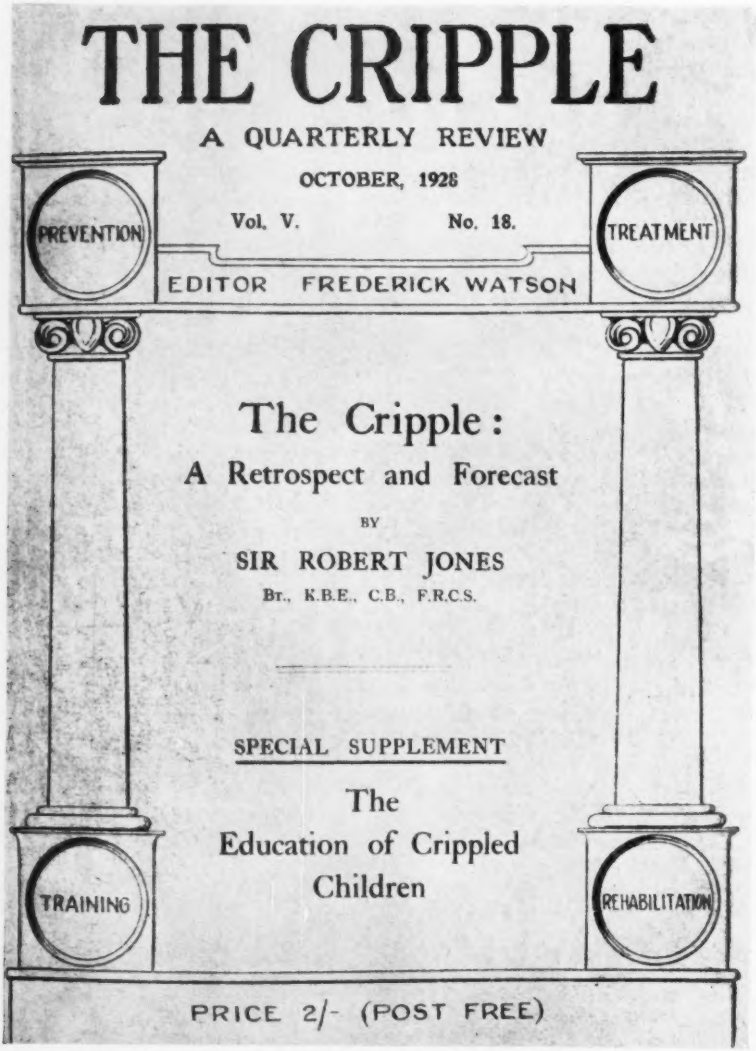
The British Medical Association formed an orthopaedic section in 1935. Since then it has been active at every annual meeting in providing information of value for the general practitioner. The Association has also an orthopaedic consultants' committee which looks after the interests of orthopaedics in the interminable consultations with Government departments.

Several small local orthopaedic clubs have grown up, the oldest of which is the Little Orthopaedic Club in London, named after W. J. Little, with a membership of nine. At present a similar club is being organised in Northern and Southern Ireland and there are similar developments in provincial centres.

The Robert Jones Dining Club was formed in 1928 by Robert's pupils and friends when they presented him with the famous Birthday book to which they had all made contributions in honour of his seventieth birthday. It meets annually after the Robert Jones Memorial Lecture at the Royal College of Surgeons of England. Its British membership is restricted to twenty, together with a few distinguished foreign members. At about the same time the friends and pupils of Robert Jones in the United States formed a similar club of very restricted membership in his memory.

JOURNALS

Orthopaedic activities in Great Britain were first reported formally in the *Proceedings of the Royal Society of Medicine*. In America *The Transactions of the American Orthopaedic Association* were published from 1889, and became *The American Journal of Orthopaedic Surgery* in 1903. In 1919 the name was again changed to *The Journal of Orthopaedic Surgery* when it became the official publication of the American and British Orthopaedic Associations. In 1922 Dr E. G. Brackett took over the Editorship and the journal was renamed *The Journal of Bone and Joint Surgery*. For more than twenty years this remarkable man devoted all his time, energies and literary acumen, until the very day he died. The Journal was his child and he nursed it to adult stature with intense individualistic zeal. In his determination to maintain



Title page of *The Cripple*, a journal published quarterly between 1924 and 1930.

a high standard of publication he was often firm even to the point of being stubborn, but his judgment was seldom wrong. Under his guidance the Journal acquired remarkable prestige and its circulation grew. As British orthopaedics developed it became increasingly obvious that more space for publication of British work was required than the American journal could possibly afford. Furthermore in 1933 it had become the official mouthpiece of the newly developed and very large American Academy of Orthopaedic Surgery—an additional commitment making voracious demands for space. At an historic meeting in London in 1947 between representatives of the two American bodies and the British Orthopaedic Association it was decided to continue a co-operative effort and to publish a British volume of four numbers annually in addition to the American volume. The first British number appeared in February 1948. It is intended that the Journal as a whole shall be representative of all English-speaking peoples and that it will eventually become world-wide in its scope.

In July 1924 there appeared the first number of a quarterly, *The Cripples' Journal*, later known as *The Cripple*. Its purpose was to keep all workers in the field of orthopaedics, including administrators, surgeons, physiotherapists and voluntary workers, informed of the progress of orthopaedic surgery as a technical and social service in Britain and the world. It was felt important too that it should use its influence in stimulating and moulding public opinion on behalf of the adult as well as the child cripple. It performed these functions nobly under the devoted editorship of Frederick Watson, the enlightened, energetic and persuasive son-in-law of Robert Jones. It is fascinating now to read all the numbers of this publication in its short life between 1924 and 1930. Its contributions contain the very essence of the history of orthopaedic development in this country and abroad. The voices of many orthopaedic surgeons and old friends of orthopaedics echo from its pages—Robert Jones, John Ridlon, Muirhead Little, Agnes Hunt, Mürk Jansen, Patrick Haglund, Robert Osgood, A. H. Tubby, Jacques Calvé, Hans Spitzy, Putti, Henry Turner, Alwyn Smith, de Courcy Wheeler, Daw, Lynn-Thomas, C. J. Macalister, Elmslie, Lyle Cummins, Varrier Jones, Henry Gauvain; and others still happily amongst us—McCrae Aitken, Harry Platt, Gathorne Girdlestone, Arthur Rocyn Jones, James Mennell, Maud Forrester-Brown and Edward Mellanby. Lay friends there are in abundance—Edgar Allen, the American president of the International Society for Crippled Children; Dame Georgiana Buller, still an ardent campaigner in orthopaedic development; Morley Roberts; Francis Brett Young; St John Ervine; Maud Royden, Sister Teresa Fraser, and the two immortals, Miss Eglantyne Jebb and Miss C. R. Buxton who in 1919 launched the "Save the Children Fund" on behalf of the children of ravaged Europe which led to the famous Declaration of Geneva by the League of Nations in 1924. This is to mention but a few.

We have noted how the problem of the crippled children stirred the public conscience. What happened to the child when adolescence and adult life were reached had no similar popular appeal in the 'twenties. When treatment, education and after-care of the crippled child were well established by the implementation of the Fisher Education Act in 1926, *The Cripple* concentrated its energies in the cause of the adult cripple. Its frontispiece aptly proclaims its creed—Prevention, Treatment, Rehabilitation, Training. It was sad that in 1930, mainly for lack of funds, this splendid venture ceased. A valediction by Frederick Watson, *Civilization and the Cripple*, published separately, is an outstanding historical and social analysis of the cripple problem and, like the Journal, can be read with great pleasure and profit even to-day.

THREE WARS

The first half of the century has been disturbed by three wars. In the Boer War it has been said that the organisation for the treatment of wounded soldiers was such that "a distinguished surgeon could rush out in a blaze of publicity to the seat of war, do a number of spectacular operations and return in six weeks with an enhanced reputation." We read of

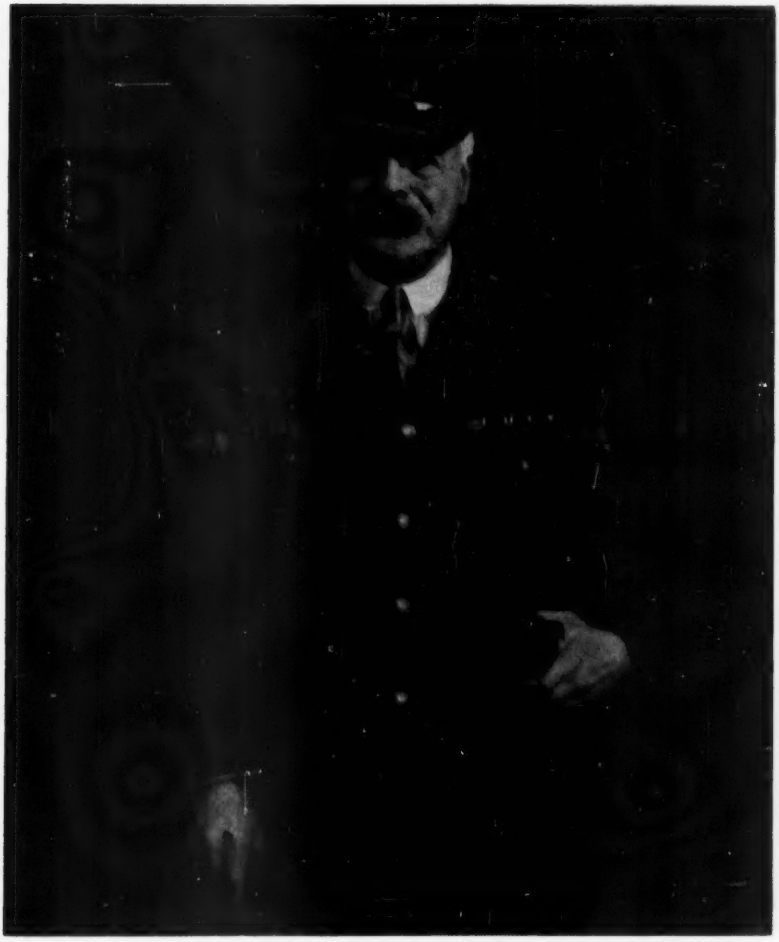
T. H. Openshaw being carried shoulder-high along a London railway platform by his colleagues and students of the London Hospital when he left for the South African War. Our much respected doyen of orthopaedics, Sir H. A. Thomas Fairbank, served as a unit medical officer with the troops in South Africa.

World War I (1914–18) had not been many weeks old before the retreat from Mons, the battles of the Marne and the Aisne, and the first battle of Ypres, made it clear that casualties would be on an enormous scale. It should have been obvious that treatment of bone and joint, muscle and nerve injuries must play an important part in the restoration of the wounded. It was left to Robert Jones to indicate that there was no adequate provision for the treatment of crippled and deformed soldiers, who were being discharged rapidly from the services, as Jones put it, " unfitted either for military or civilian life . . . to become foci for seething discontent and a menace to successful recruiting." The Director-General of the Army Medical Services asked Robert Jones for help. It was forthcoming quickly. Early in 1915, Alder Hey in Liverpool was opened with 400 beds with Robert Jones in charge of the surgical division assisted by Major T. Armour and Captain T. P. McMurray; the hospital was reserved entirely for patients likely to be benefited by orthopaedic treatment. Robert Jones travelled widely finding patients who required reconstructive surgery, demonstrating, lecturing and writing. He preached the importance of segregation of patients, and the need for continuity of treatment and for unity of control until the best possible result had been achieved. Only in this way could indiscriminate surgery be prevented; only in this way could surgeons, accustomed to treat an occasional accident in peace-time, be trained to deal with the shattering compound injuries of war. At the front in France he demonstrated how adequate splinting at the earliest possible moment could prevent shock and lower mortality. All now know how under his guidance the incidence of mortality for compound fractures of the femur fell from 80 per cent to 20 per cent. He wrote: " To what are we to ascribe this dramatic change? First and foremost to the recognition, too long delayed, of the value of the Thomas splint, and to its distribution to the regimental aid posts." The caliper splint which had been used in Liverpool for forty years had again proved its value. By 1916 it was in general use throughout the entire front.

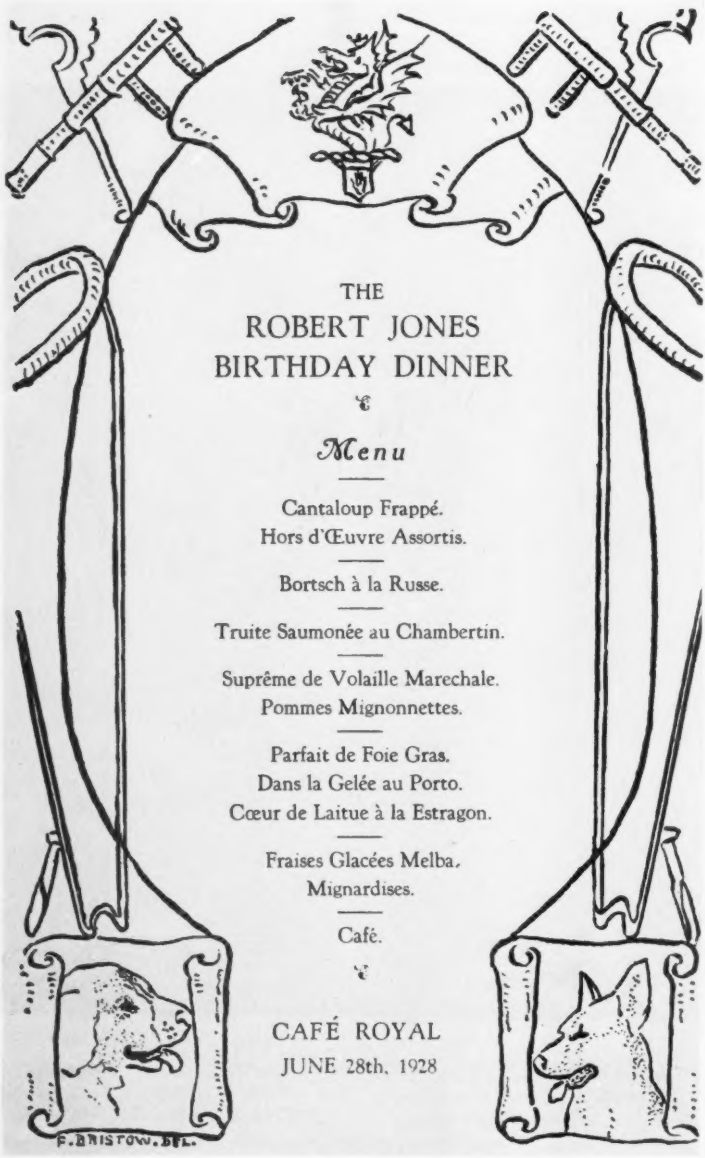
As casualties increased, Alder Hey was not enough; but its work had made a tremendous impression. In 1916 the Hammersmith Workhouse at Shepherd's Bush (now the hospital of the Postgraduate Medical School of London) was opened with the help of Red Cross funds as the Shepherd's Bush Military Orthopaedic Hospital with 800 beds. Some fifteen similar institutions, labelled with the daring and unfamiliar title of " Orthopaedic Centres," were organised all over the country until eventually 30,000 beds were available for the wounded. Because it was felt that something more was necessary than good primary treatment, sound definitive treatment and the physiotherapy available in those days, curative workshops were established. These were the ancestors of the rehabilitation centres of the present day. The monotony of treatment by massage, electricity and movements with elaborate mechanical apparatus was relieved or replaced by productive work with lathes, treadles, fretsaws and other tools of the workshop. Morale was improved enormously. " If hands and fingers are stiff," wrote Sir Robert, " working with a big swab to clean windows or with a paint brush is a more interesting occupation than gripping spring dumb-bells."

The most notable of these curative workshops was undoubtedly that at Shepherd's Bush where 500 of the 800 patients were employed at regular work " which fosters habits of diligence and self-respect, and converts indolent and often discontented patients into happy men who soon begin to feel that they are becoming useful members of society and not mere derelicts."

The rule that a soldier should be invalided and discharged from a military hospital immediately it was clear that he could never return to the front was opposed tenaciously and effectively by Robert Jones. He visualised perhaps more clearly than anyone else the



ROBERT JONES in uniform.
(Reproduced by permission of the Royal College of Surgeons of England.)



Menu of Robert Jones Birthday Dinner—illustrated by Mrs Rowley Bristow. The meal was almost certainly chosen by Bristow himself.

size and importance of the social problem involved if this rule were followed. He wrote: "It is quite true that the most important object of the military mind is to end the war successfully; but there is absolutely no reason why that desire and determination should clash with the civil one. On the contrary, an early understanding is essential to the full success of either. When the War Office says that men should be discharged from the Army so soon as it is known that they will not be fit for service they cannot *really* mean it. If they did it would involve the discharge of half our wounded in the most critical stages of disease, many of them to die, and most of them destined to deformity and functional disability. It is clear, therefore, that whatever the War Office says, they would never dare to give effect to so inhuman an act . . . The problem requires a telescope rather than a microscope. Statesmen must and will see that the economic solution is only satisfactory if the wounded soldier becomes a national asset instead of a discontented derelict . . . My opinion is that no soldier should be discharged from the Army until everything is done for him to make him a healthy and efficient citizen, and when the war is ended he should not be discharged until he is declared to be fit and fortified by the necessary help or knowledge which will enable him to take an honourable part in life. If a soldier knows beforehand that we are striving to make him functionally useful, and not necessarily with the intention of sending him to fight, the psychological effect is such as to materially expedite his recovery." How true and how obvious. Yet in World War II the same crusade had to be fought by Robert Jones's successors. In the face of ineptitude, indifference and misunderstanding he fought and won the battle for the greatest possible restoration of function of the disabled soldier before his discharge to civil life. After the Armistice his principles and many of his orthopaedic centres were incorporated in the newly formed Ministry of Pensions to which he remained an adviser until his death. Regretfully and with great disappointment he was to see Shepherd's Bush, which with its well-proven organisation and its comprehensive amenities he had hoped would become a permanent home of British orthopaedics, returned in 1925 to its function and status as a Poor Law Hospital. It had been a landmark in the organised treatment of the crippled adult, as sixteen years earlier Heswall and Baschurch had been for the crippled child.

It is impossible to read the orthopaedic history of World War I, as indeed it is impossible to study the development of British orthopaedics, without being impressed over and over again by the stature of Robert Jones. His vision and singleness of purpose were remarkable. His resilience and tact enabled him to achieve almost every objective even in the uncongenial surroundings of the War Office. His unique experience as surgeon to the Manchester Ship Canal during its construction between 1887 and 1894 was indeed, as Frederick Watson wrote, "like a rehearsal in miniature for what was then not even a cloud the size of a man's hand." He had "learnt the elements of organisation, of supervision and of treatment of desperate casualties under primitive conditions." He was clearly the ideal Inspector of Military Orthopaedics, though the senior officers of that day could hardly have regarded him as an ideal Major-General, the rank which he finally achieved. But he could not have succeeded without support for his views and practical help to do the work. He was fortunate in having the support of powerful general surgeons—Berkeley Moynihan of Leeds, Harold Stiles of Edinburgh and Lynn-Thomas of Cardiff. For practical help he gathered round him a band of younger colleagues who became the leaders of orthopaedics in the second, third and fourth decades of this century; McCrae Aitken, Girdlestone, Fairbank, Bankart, Platt, Buxton and Whitchurch Howell are the only survivors. Almost the only active surgeons practising orthopaedics who were not associated with him were Tubby, who became consultant surgeon to the British Mediterranean and the Egyptian Expeditionary Forces; Openshaw, who was consultant surgeon to the Eastern Command and who was probably the only surgeon with orthopaedic leanings to fail in co-operating harmoniously with Robert Jones; and H. A. T. Fairbank, who spent most of the war as assistant consultant to Robert Kelly in Salonika, although on his return he and St. John Buxton worked together at Shepherd's Bush. This team of helpers worked unceasingly, but

from 1916 onwards, as casualties increased and more orthopaedic centres opened, the need for more surgeons became acute. The problem was solved when the United States came into the war in April 1917. Twenty American orthopaedic surgeons arrived at the end of May under the " command " of Joel Goldthwait, who soon returned to America to collect a further sixty. From then until the war ended there were never less than sixty or seventy young American orthopaedic surgeons officially assigned and paid by the American Army to serve with the British. About 400 American surgeons in all received training and worked hard under the aegis of Robert Jones, ably assisted by Robert Osgood of Boston who had become his second-in-command. From that time onwards the orthopaedic centres were fully and effectively staffed. This intermingling of English-speaking surgeons formed many lasting friendships and left an indelible stamp on orthopaedics in America and Britain.

In World War II the basic pattern of military orthopaedics conformed to that so well established in World War I. There were, of course, differences associated with the changed type of war, its world-wide extent, the development of new weapons and, in particular, the extensive use of tanks and aircraft. In spite of the lessons of 1914–18 it was some time before an effective orthopaedic machine was set in motion. The late Rowley Bristow was appointed Consultant in Orthopaedics to the War Office in 1941. St. John D. Buxton, the late James Eastwood of Liverpool and Philip Wiles were Consultants in the Middle East and India. The Royal Navy had the late Robert Milne as its Consultant. Watson-Jones and Osmond-Clarke were the Consultants to the Royal Air Force. An important advance on the conditions that prevailed in World War I was the establishment by the Ministry of Health of the Emergency Medical Service. New hutted hospitals were built and old ones extended to provide not only extra accommodation but also special centres for the segregation of battle and air-raid casualties in the military and civilian population. There were, for example, five special centres for nerve injuries, three in England and two in Scotland, to which most of these injuries in sailors, soldiers, airmen and civilians were diverted. Orthopaedic centres were numerous and provided what was lacking in World War I—a guarantee that the injured man or woman would receive adequate specialised treatment, including rehabilitation, whether he was in a military service or not. Thomas Fairbank was Consultant to the Ministry with Harry Platt as his deputy.

In general this orthopaedic organisation in World War II proved satisfactory. There was no doubt that segregation of patients into special centres, provided the experts were good, ensured the highest standard of treatment. So far as terrain, state of the fighting, water supplies and transport allowed, specialist centres were located as close as possible to the fighting fronts, usually in the Base Hospitals. Initial treatment was provided at Field Surgical Units, including resuscitation, wound excision and adequate splinting, before transportation back to the Casualty Clearing Station or the orthopaedic units of the Base General Hospitals. Long-term casualties were returned to Great Britain by sea or air when medical and other considerations permitted. A good example of organisation for this purpose occurred after the landing in Normandy on June 6, 1944. All serious casualties from France were evacuated by air to England, a suitable air base having been prepared and equipped for their reception at an airfield close to a large Royal Air Force orthopaedic centre specially enlarged and manned to deal with casualties on a large scale. Cases were sorted here and distributed to appropriate hospitals, military or civilian, throughout the country. Eventually, of course, as the fronts moved eastwards service hospitals with facilities for definitive treatment of orthopaedic patients were established in Western Europe.

In one of the services—the R.A.F.—it was possible to arrange an almost ideal orthopaedic organisation, an elaboration of Robert Jones's plan in World War I. It comprised twelve orthopaedic centres in England, three in Scotland and five overseas. Each of the main orthopaedic centres was a unit in a general hospital staffed by an orthopaedic surgeon with one or two assistants. Ancillary staff included secretaries, one radiographer, two rehabilitation orderlies,

one plaster room orderly and one clinical photographer. A sister trained in orthopaedic technique was available in the operating theatre. Accommodation also included a consulting room, secretaries' room, out-patient waiting room (almost unheard of in a military hospital!), plaster room, photographic room and equipment store. In addition to the usual service documents a uniform system of orthopaedic records was common to all centres; out-patient and in-patient notes, including prints of all important radiographs and clinical photographs, were entered in the same case sheet which went with the patient if he was moved from one centre to another. Each surgeon was allowed full clinical freedom to treat his patients by whatever method he selected, provided that basic surgical and orthopaedic principles were observed. Advice was readily available by regular visits and complete ward rounds by the consultants who co-ordinated the work of all the centres. Perhaps one of the most difficult tasks encountered by the consultants was to convince high administrative authority of the importance of good records and the economy of clinical secretarial assistance. It seemed almost impossible to make the point that one doctor and a secretary can see and record the details of as many patients as can three or more doctors who have to write their findings in longhand; and secretaries cost less than doctors!

Rehabilitation—The lessons learnt from the experience of the " curative workshops " of Robert Jones at his orthopaedic centres in World War I and from the " Convalescent Camp " organised in Salonika after 1915 by Thomas Fairbank were quickly forgotten by most surgeons between the two great world wars. As we have noted before, organised rehabilitation—a disagreeable word but there seems none to replace it—was being carried out alone by Dr H. E. Moore at the Crewe Hospital for injured employees of the London, Midland and Scottish Railway. There were some, notably Watson-Jones, Gywnne Maitland and Hugh Griffiths, who, impressed by Moore's work, also strove unceasingly from the early 'thirties onwards for more comprehensive remedial treatment of the injured. It was fortunate that Watson-Jones as Consultant to the Royal Air Force was enabled, with the powerful co-operation of an enlightened Director-General of Medical Services, Sir Harold Whittingham, to organise a comprehensive orthopaedic scheme including rehabilitation for all injured airmen. Four main centres were in constant use during the war, working in the closest co-operation with the orthopaedic hospital units. They were staffed by hand-picked men—selected as much for their capacity to inspire confidence and to foster a high morale among patients as for their technical skill as doctors—physiotherapists, nurses, clinical secretaries and physical training instructors. It was a most gratifying aspect of orthopaedic work in the Royal Air Force that rehabilitation, physical and mental, began in the hospital ward within a day or two of the injury by rehabilitation orderlies whose sole job it was; and that the process was continued in a well-organised residential rehabilitation unit long after the gross features of the injury—fracture, dislocation or soft-tissue injury, had been overcome.

The principles laid down by Robert Jones were faithfully fulfilled—segregation and unity of control until maximum recovery was achieved. In the Royal Air Force it was fortunately possible to retain the injured until this result had been gained. There is little doubt that the value of rehabilitation was reflected in a more rapid and a more complete restoration of function. No less than 77 per cent of injured men and women returned to full duty, and 18 per cent were re-trained in other duties; and only 5 per cent were invalided because their recovery did not fit them for service life or because of psychological complications. Similar highly efficient units were organised by the Army both in Home and Overseas Commands, and by the Royal Navy. When the United States entered the war their medical corps stationed in this country was quick to appreciate the advantages of rehabilitation and two or more large and very effective units were quickly in use. It is an interesting commentary on the value of rehabilitation that the Royal Air Force has felt it wise to continue its centres in peace-time.

The surgical principles of orthopaedic treatment did not alter much in the two major

Rehabilitation. This view epitomises the spirit of rehabilitation. There is only one uninjured man in this group but it is impossible to single him out.

Rehabilitation. Plaster of Paris is no bar to the enjoyment of the traditional British sport, cricket! (Reproduced from Watson Jones's *Fractures and Joint Injuries* by permission of the author and publisher.)

wars of the first half of the century. There were some changes in methods of treatment, and the " advance of civilisation " had made weapons of war more destructive and increased their range so that civilians of all ages were involved almost equally with the fighting men. Open wounds of the extremities comprised about 70 per cent of all injuries, but there were many new factors in World War II that added to the complexity of battle injuries—the increased destructive power of modern projectiles; the high speed of modern transport and combat vehicles on land and sea and in the air; the very great increase in bomb blast which, apart from its own direct action in causing injuries, added the problems of burial, crush syndrome and so forth; and the hazards associated with special tasks as, for example, parachuting. Thus injuries tended to be multiple and it was not uncommon to have to treat as many as a dozen or more separate injuries in the same patient. On the other hand, these factors were very considerably offset by better medical organisation at all stages of prophylaxis and treatment, by segregation of special injuries and by advances in chemotherapy, to mention but a few of the improvements in the medical care of the wounded.

First-aid treatment was greatly reinforced by the increased facilities for combating shock, haemorrhage and infection. The Thomas's splint performed the same life- and limb-saving functions as in World War I. Immobilisation afforded by the splint was often reinforced by plaster of Paris, the combination being termed the " Tobruk " splint, a predecessor of which was in use in the early days of the London " blitz." Tourniquets were discouraged, though they could not for reasons of morale be abandoned. Infection was combated by the early application of field service dressings, the injection of anti-tetanic serum and gas-gangrene antitoxin, and the oral administration of sulphonamides; and eventually by penicillin. But careful surgical excision of the damaged tissues and of débris was *the most important* factor in preventing wound infection. The incidence and mortality of gas gangrene had been reduced by competent surgery in World War I to 1 per cent and 22 per cent respectively. In the recent war, by adequate wound excision, transfusion and antibiotics, the mortality fell to negligible levels. During a brief but regrettable phase of the last war, when supplies of penicillin were plentiful, some surgeons felt that chemotherapy would be a substitute for wound excision. Fortunately this phase did not last long because the limitations of antiseptics in wound treatment became, as often before, obvious—a drug cannot remove clothing, metal or necrotic tissue from a wound. If wounds were already infected they were treated by free incision to promote drainage. After the teaching of Winnett Orr, and later of Trueta, wounds were left open and kept open by gauze dressings until healing from the depths of the wound by granulation tissue had occurred. Severed nerves and tendons were not sutured at the time of wound excision. By the middle of the war attention was directed to providing early skin cover for wounds. Eventually delayed primary suture or skin grafting undertaken within five to ten days of successful primary excision secured early healing in almost 90 per cent of patients. This was a notable advance because reinfection from the exterior was minimised, healing was more rapid, the formation of scar tissue in muscle, fascia and skin was much less; and a mobile and stable linear scar was often secured and the definitive treatment of an underlying fracture could be undertaken earlier by whatever appeared most desirable.

Perhaps the greatest advance in World War II was the efficacy of resuscitation. Glucose-saline, plasma and blood were available on a large scale and close to the front line. They were administered at advanced dressing stations, on board ship and in aircraft. These measures played a tremendous part in preventing infection and, by preserving life, confronted surgeons and particularly orthopaedic surgeons with problems of a complexity not previously encountered.

Definitive treatment—As noted, the Thomas's splint held its own in World War II as a first-aid splint. For compound and simple fractures of the femoral shaft it was used in World War I almost exclusively for definitive treatment. In the second war it was powerfully challenged, though never beaten, by the " closed " plaster of Paris spica. For all other

injuries plaster splints were used almost exclusively in the recent war. Internal fixation was used sparingly and carefully. The arrival of the Americans in 1942 gave it a new impetus, though British surgeons always avoided its use in compound injuries even when the claims for the sulphonamides and the antibiotics were at their peak. Internal fixation by metal or bone was judiciously used for unstable simple fractures; a few surgeons relied on metal plates alone for the splinting of tibial and forearm fractures. Towards the end of the war B. H. Burns had begun to revive an old method of operative treatment—intramedullary fixation by a metal nail of his own design. Soon afterwards a similar method of internal fixation was noted in returning prisoners of war. It had been advocated by Küntscher of Kiel in 1938–9 and was used extensively by the Germans from then onwards. Experience has shown that it possessed a very real place in fracture treatment, especially in transverse fractures of the mid-shaft of the femur. Its great advantage, and an important one in peace or war, is the rapid restoration of complete movement of the knee joint.

Burns—Severe burns were a frequent complication of fractures in the crews of aircraft, tanks and ships. First and second degree burns usually healed rapidly under the plaster of Paris splint immobilising the fracture. Burns of the third degree presented a formidable problem for which no hard and fast rules could be formulated except that the injury causing the greater immediate risk to life had priority in treatment—and this was usually the burn. A splint which combined immobilisiation with access to the burns for dressing and early skin grafting was the best compromise, and it consisted usually of plaster of Paris with a window over the burn. A burns centre and an orthopaedic unit in the same hospital provided the valuable combined efforts of plastic and orthopaedic surgeon, without both of whom these desperate injuries could not have been handled adequately.

Peripheral nerve injuries—The work of Henry Head and James Sherran in the first decade of the century is an outstanding British contribution to the problem of peripheral nerve injuries. In both wars large numbers of them were treated. In Britain, though not in America, they have been included in the scope of orthopaedic surgery since the 1914–18 war. Although then the organisation and treatment afforded—which included a comprehensive service of physiotherapy—were excellent, the documentation and follow-up system were unfortunately inadequate. Platt and Bristow in presenting a report on peripheral nerve injuries to the International Society of Surgery in 1923 were forced to rely largely on impressions in reaching their conclusions. In his Robert Jones Lecture in 1945 Bristow said: "Looking back and comparing the surgery of the war of 1914–18 and of the years which immediately followed with the surgery of the present war, it is doubtful whether there has been any great advance in technique or in operative skill which would lead us to expect an improvement in results." Nevertheless there were advances in methods of diagnosis and in technique which have been most carefully and accurately recorded and which will shortly become available as a report of the Medical Research Council. They include improvements in electrical testing; electromyography; the sweat test; and the use of fibrinogen plasma as a cement for joining nerve ends. The lessons of both wars on the management of peripheral nerve injuries may be summarised as follows: 1) There is no indication for immediate suture and it must never be attempted in a grossly contaminated wound. 2) The best time for suture is about three or four weeks after division. By this time the extent of interstitial fibrosis is recognisable and the correct length of stump to be resected can be assessed. 3) The more distally placed the nerve division in the limb the better the prognosis after suture. 4) The technique of suture is important. The assumption of the extremes of joint movement to maintain end-to-end contact of the nerve ends is useless because the suture line is always disrupted later by stretching. 5) Autogenous nerve grafting has a place in treatment. 6) Post-operative treatment including galvanic muscle stimulation, is of great importance. 7) Investigation and treatment of peripheral nerve injuries is so highly specialised that patients with these injuries should be segregated in special centres.

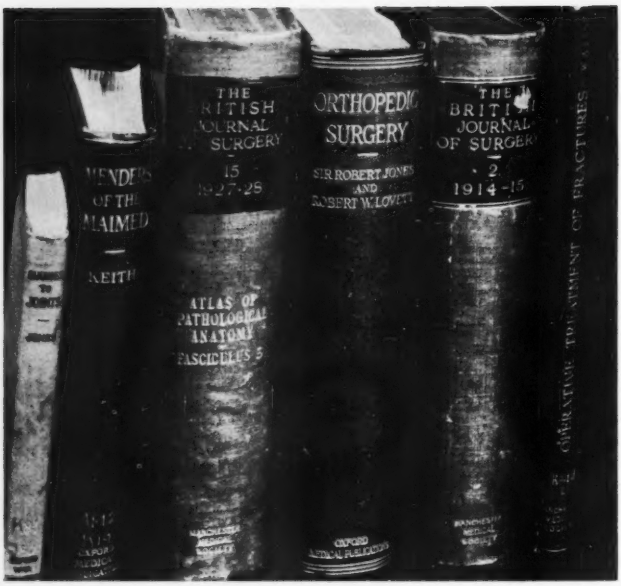
Major amputations—In consequence of better surgical management, better chemotherapy and the wider knowledge that a useful limb can be saved if its distal blood supply is adequate, the numbers of amputations in World War II were greatly reduced. Loss of soft tissue or of bone, however extensive, was not considered sufficient indication for immediate amputation. If urgent amputation proved necessary in compound injuries it was best done by an open technique, retraction of the skin being prevented by fixing it with a few sutures over a small dressing. From the combined experience of surgeons and limb-fitters definitive amputations were standardised so that in World War II only four major amputations were advised: a five-inch below-knee stump; an eleven-inch above-knee stump; a seven-inch below-elbow stump; and an eight-inch above-elbow stump. The end-bearing Stokes-Gritti and Symes amputations still advocated by the Canadians and others were, and to the regret of some of us still are, unpopular with British limb-makers. Nerves are divided cleanly with a sharp knife and not meddled with further; haemostasis is meticulous; flaps should include only skin, subcutaneous tissue and deep fascia; scars should usually be at the end and not the side of the stump. Cineplastic and Krukenberg's amputations have not been used to any extent in this country in either war. Suction sockets, started after World War I, whose limited use for thigh amputations has been improved, had achieved a greater though restricted popularity.

CONCLUSION

It has been fascinating to trace the gradual erection of the British edifice of orthopaedics, and nostalgic to recapture a memory, however fleeting, of some of the figures who built it and taught us so much of our sum of knowledge half-way through the twentieth century—the remarkable spell of Robert Jones, the lofty, ascetic Tubby, the pugnacious Openshaw, the forceful and enthusiastic Hey Groves, the earnest but irascible Laming Evans, the equable and thoughtful Elmslie, the restless and exuberant Trethowan. It is always tempting to conclude: " those were the days." It is probably wise to do no more than record the events and leave judgment of progress to a later century. But we are being judged already and not always kindly or even truthfully. We are justified surely in priding ourselves on what has already been achieved, and on the service that orthopaedic surgery now gives to the community and promises for the future. In concern for this aspect of our work we have perhaps tended to neglect our capacity for basic research. But we are aware of this shortcoming, as witness our closer relationships with research departments of universities and royal colleges, and our increasing contacts with colleagues in the basic sciences. Finally, apart from the most intellectual snob and the pessimistic cynic, all must surely rejoice at the enthusiasm, industry and ability of our young colleagues—the orthopaedic surgeons of to-morrow.

I acknowledge gratefully the help I have received from A. Rocyn Jones, W. E. Tanner, Harry Platt, R. Watson-Jones and a host of other colleagues. Mr L. T. Morton, the information officer of the British Medical Association, has done much to lighten my burden by his researches into Acts of Parliament. Among the enormous number of books and articles that have been consulted I am especially indebted to the *Birthday Volume*, the *Official History of World War I*, *Menders of the Maimed*, *Life of Sir Robert Jones. This is my Life* by Agnes Hunt, *British Masters of Medicine*, *Civilisation and the Cripple*, *The Cripple*, the Annual Reports of the Central Council for the Care of Cripples, and Bick's *Source Book of Orthopaedics*.

The illustrations of the early activities of the British Orthopaedic Association are taken from the papers of the late R. C. Elmslie through the kindness of Mrs R. C. Elmslie.



SOME CLASSICS OF BRITISH ORTHOPAEDIC LITERATURE

D. Ll. Griffiths, Manchester, England

Orthopaedic literature has changed less in Britain in the last fifty years than has the literature of other medical subjects. The day of the text-book by a single author is not yet passed; monographs and papers published in journals still possess the lively personal character that has distinguished British surgical writing in the past. In one sense this may reflect a lack of the coldly scientific outlook, but if our papers have not always been characterised by the accuracy that comes of statistical method and detailed experimental protocols they have also avoided the impersonal dullness which so often mars better science. British surgical literature has always had a humanistic touch: it still has.

In reviewing the products of this period one naturally thinks first of the writers and—before all others—of Robert Jones who with his collaborators and pupils created so many of the classics of the period. However, before Jones there was Tubby, and before Tubby, Macewen.

Macewen—Sir William Macewen, whose name is one of the greatest in the whole history of surgery, was so much a figure of the nineteenth century that one recalls with a little surprise that his last publication on bone growth was dated 1923, and with even more that his classic work on osteogenesis appeared in 1912. *The Growth of Bone* is a model of surgical writing. It is short, very clear and one of the most interesting books in any surgeon's library. It masses its detailed evidence logically and carefully, and the fact that so little of the experimental work it reports has been questioned after many confirmatory experiments is a further sign of its unique quality. Most of the work was done, and much of it published, before the turn of the century, but Macewen had to wait until 1908 to see the radiographic evidence (now reproduced again on the next page) which gave him final proof of the success of his classic experiment in homogenous bone grafting. One can only wonder that this remarkable book and the work it recounted have been of so little avail in preventing the misleading

"chemical" theories of bone formation which led orthopaedic physiology far astray less than twenty years later.

Tubby—In the first year of this century the standard British text-book of its subject was A. H. Tubby's *Deformities* published in 1896. The limited field of the orthopaedic surgeon of those days is shown by a remark in the preface that it did not include "tubercular osteitis and arthritis of the hip and knee," which was still the province of the general surgeon. By 1912 those limitations had gone and Tubby's second edition had to be rewritten almost completely. The title then became *Deformities, including Diseases of the Bones and Joints, a Text-book of Orthopaedic Surgery*. The book was enlarged and filled two volumes. "Rontgen-ray illustrations" were made from negatives belonging to Thurstan Holland and Alban Köhler, and the first really modern text-book of orthopaedics was thus produced in Britain. It is still of great value, though perhaps more for its account of deformities than for the additions which completed it. Read after the lapse of forty years, the first edition is the better book.

Robert Jones—In 1903 Tubby co-operated with Robert Jones in a small book of three hundred pages on the *Surgery of Paralysis*. Jones already had several papers to his credit before the turn of the century and this book is an interesting part of his literary output before the first world war. It is no doubt much less important than his famous address to the Surgical Section of the Royal Society of Medicine in 1910 on "Fractures in the Neighbourhood of Joints," in which he laid down the principles of mobilisation of elbow injuries and his condemnation of passive movement; nevertheless it is an interesting landmark in pre-war orthopaedic literature. Another paper, published in the first issue of the *British Journal of Surgery* in 1913, was written with Alwyn Smith on ruptured crucial ligaments and fractures of the tibial spine; but in literature as in other matters it took the first world war to bring the full flowering of Robert Jones.

Figure 60 from Macewen's *Growth of Bone* (published in 1912 by James Maclehose & Sons). The regenerated humerus thirty years after replacement of almost the whole diaphysis by pieces of tibia obtained during wedge osteotomies for knock-knee. One of Macewen's classical experiments which discredited the periosteum as the sole source of new bone.

His first war book, *Injuries to Joints*, was written (as we were told by McMurray) in two weeks. It had been requested by the Army Medical Department and was published in 1915 as an Oxford War Primer. A pocket-sized book with a few vivid illustrations, it reached three editions and was many times reprinted. The help of McCrae Aitken was acknowledged in the first two editions, and of Harry Platt in the third edition published in March 1930.

Notes on Military Orthopaedics appeared in 1917. This was the parent of a handsome two-volume post-war book *Orthopaedic Surgery of Injuries* by various authors under the editorship of Robert Jones. The preface included his much misquoted definition: "Orthopaedic surgery is based on, and consists of, the recognition and practice of definite principles of treatment, whether operative, manipulative or educational, which lead to the restoration of function in nerves and muscles and in deformed or disabled limbs." (*Page* vii.) Jones himself wrote the chapters on malunion of the femur, ankylosis and stiff joints, and flail joints. The second volume included contributions by Stiles and Bristow on peripheral nerve injuries, and by Wood Jones on trick movements. It is unique among orthopaedic books in that one

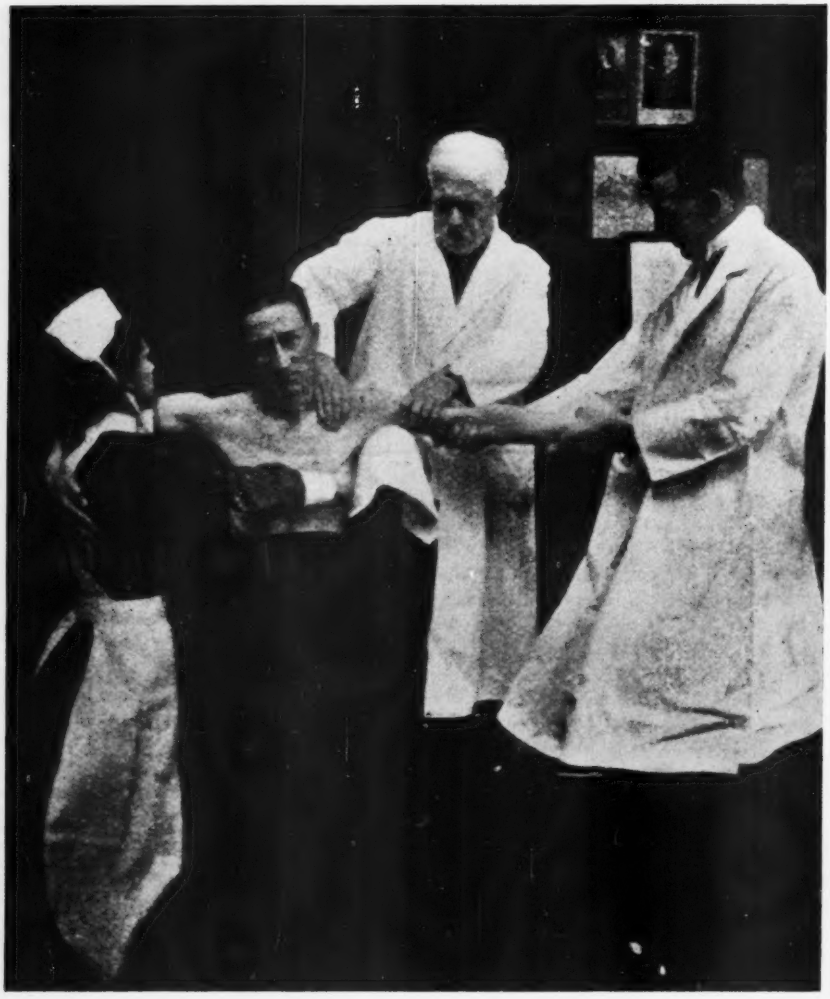
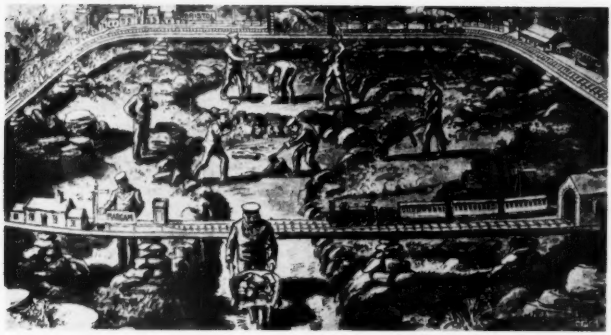
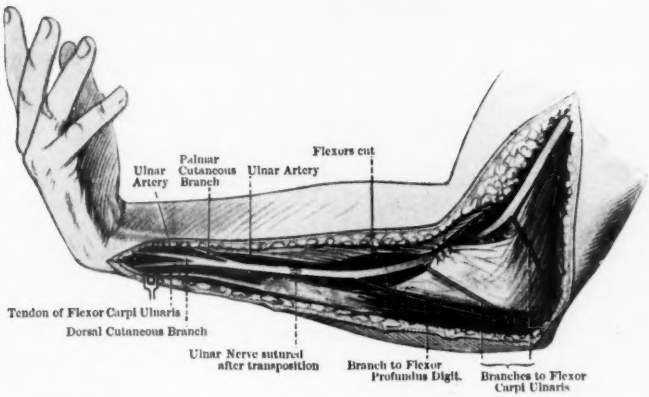


FIG. 5. REDUCING DISLOCATED SHOULDER.

The photograph above is reproduced from page 66 of *Injuries to Joints*, which was published in 1915 as an Oxford War Primer. Robert Jones, reducing a dislocation over his knee, is assisted by T. P. McMurray.





Three illustrations from *Orthopaedic Surgery of Injuries* (Oxford Medical Publications, 1921). At the top Robert Jones is using a Thomas's wrench to refracture a malunited Colles fracture. Below this is a sketch, "Training ground for artificial arms," from the chapter contributed by Lynn-Thomas. The drawing of the forearm, showing resection of a lesion of the ulnar nerve and end-to-end suture after anterior transposition of the nerve at the elbow, is from Stiles's chapter on "Injuries of the Peripheral Spinal Nerves."

chapter was written by a king—the exiled King Manuel of Portugal who was Jones's friend and worked with great enthusiasm at Shepherd's Bush; he wrote on the "Scheme and Organisation of Curative Workshops."

"Jones and Lovett"—For many years Jones and Lovett's *Orthopaedic Surgery*, first appearing in 1923, was the standard text-book of the English-speaking orthopaedic world. It was, of course, chiefly an American work, printed in America, and originally more Lovett than Jones. Purporting to be "a plain and practical account of those pathological conditions which we believe may properly be classified under the unsatisfactory name of orthopaedic surgery," it owed ancestry to the American work, Bradford and Lovett's *Treatise on Orthopaedic Surgery* (1890). The story of the book is told so well in Watson's *Life of Robert Jones* that nothing need

FIG. 30.—Field of operation on cartilage.

FIG. 31.—Operation on cartilage—line of incision into joint.

622.—Thomas wrench applied, showing how to use it with the hip, leaving the hands free.

Illustrations reprinted from pages 33 and 591 of Jones and Lovett (*Orthopaedic Surgery*, London 1923, published by Henry Frowde, Hodder and Stoughton).

be added—except perhaps to record the reply made by Robert Jones when the great novelist Joseph Conrad said that two thousand words a day was a desirable output. Jones, making far slower progress, remarked: "But I have to be accurate." The book is beautifully made and compares favourably with the great text-books of any branch of medicine. The illustrations can still be reproduced and show the original Jones manipulations quite unambiguously.

Lovett died in Robert Jones's home in Liverpool the year after the book was published. The second edition in 1927 was entrusted to Allison and Ober in the United States, while a very thorough revision was made in England by Robert Jones with the assistance of Harry Platt. A third edition, more than once planned, never appeared.

The Robert Jones Birthday Volume—Robert Jones's seventieth birthday was celebrated with one of the few "Festschriften" ever presented in British medicine. This book, *The Robert Jones Birthday Volume*, consisted of twenty-three essays on various orthopaedic subjects, seventeen written by old colleagues, assistants and pupils, two by his American friends

The signatures of the contributors in the original *Birthday Volume*—photograph taken and published here by permission of the Orthopaedic Library of the Liverpool Medical Institution.

part is situated much more distally than in the normal one of Fig. 9. This seems to indicate that the growth disc in the upper end of the femur adds more to the longitudinal growth of the femur than corresponds with the longitudinal growth of the femoral neck. In Fig. 10 a small femur has been drawn on a large one, and the place has been marked to which its parts have wandered after years of growth. It might be imagined that the femoral neck increases just enough in length to allow the trochanters to reach their ultimate position—as is indicated by the dotted (narrow) femoral neck—whilst at the same time the trochanters, enlarging, departed from the axis of the neck, thus following the shaded area, indicated in Fig. 10. In that case, however, it would be unintelligible that distally from the normal site of the lesser trochanter in Fig. 8 bony masses should occur which present themselves as rests of a displaced lesser trochanter. If, therefore, these masses are indeed such

FIG. 9 (normal parts for comparison).

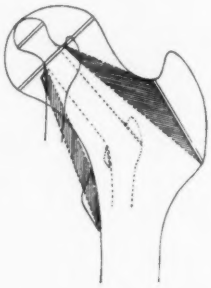


FIG. 10.

rests, the conclusion is justified that the growth disc in the upper end of the femur adds more to the length of the femur than corresponds with the longitudinal increase of the neck. From this it would follow that during growth an intricate process of displacement of the trochanters upwards and inwards is necessary with regard to the mass of the femoral neck which through growth pushes downwards and outwards; while, moreover, the curve in the area of transition between femoral neck and diaphysis and the curves in the cancelli inside the neck have constantly to shift from the upper portion of the diaphysis upward and inward. At all events the enlarged trochanters, the lessened obturator foramina and the widened socket floor in our patient display hitherto unknown phenomena in Ollier's dyschondroplasia whose nature seems to be identical with those discussed above, since they present themselves as a dissociation of one of the growth processes from the others, viz. a dissociation of resorption.

The above considerations on the growth of the femoral neck may be useful in furnishing an insight into the origin of the exostoses on the ribs of our patient W. L.

A page from "Dissociation of Bone Growth" by Murk Jansen, in *The Robert Jones Birthday Volume*.

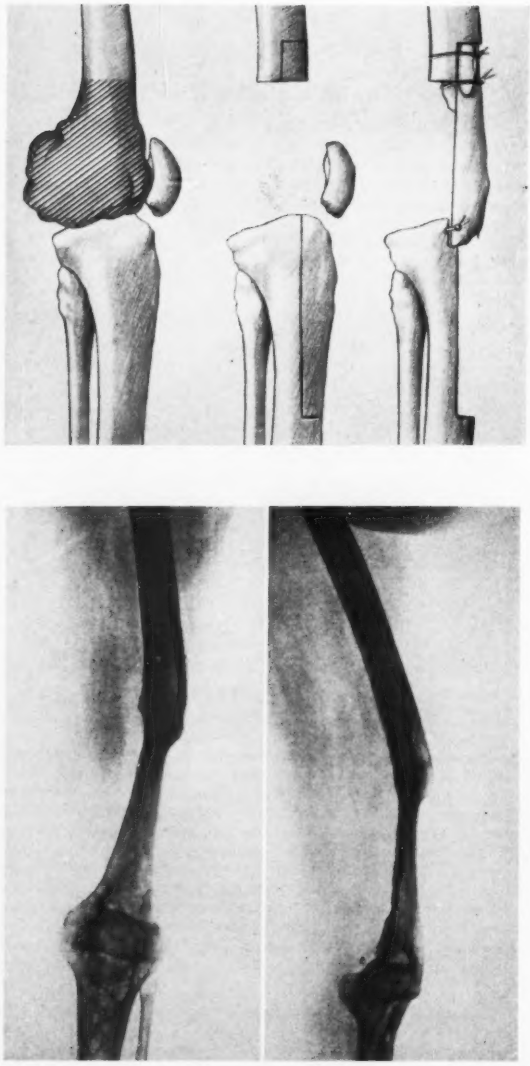
236 INFANTILE OR CERVICAL COXA VARA

with the characteristic triangular fragment showing well in the radiograms. In the first case there was no coxa vara. On general X-ray examination all these cases, however, showed a large number of other abnormalities of the skeleton, to which attention had been drawn by Mr. Barrington-Ward when he exhibited his case before the British Orthopædic Association when they visited the Hospital for Sick Children, Great Ormond Street, in 1924. In addition to the deficient ossification of the skull (parietals) and of the clavicles, these included entire absence of ossification of both pubic bones, epiphyses at either end of several metacarpals and phalanges, delayed fusion of the mandible and of the neural arches, and no sign of ossification

FIG. 15.—Bilateral infantile coxa vara in case of cranio-cleido-dysostosis. Girl aged 6 years. Note the typical triangular fragment, and other features of infantile coxa vara on both sides, and also the absence of ossification in the pubes.

of the carpal bones. There can be no doubt about this combination of abnormalities being the result of developmental errors, and the occurrence of this type of coxa vara with this condition must be regarded as the strongest possible evidence in favour of the latter also being the result of an error of development. The cause of the dysostotic affection is unknown, but various suggestions have been made. In my opinion the only theory which could account for all the abnormalities seen is that the condition is a reversion to a lower type. The clavicles are rudimentary in the carnivora and absent in the cetaceans, but I have been unable to find out whether the ossification in these agrees in other ways with that seen in the dysostotic human beings. A somewhat limited examination of the femora of these two classes in the museum of the Royal College of Surgeons has failed to disclose any specimen with marked coxa vara. The angle of inclination in the femora seen was undoubtedly less than

From " Infantile or Cervical Coxa Vara," contributed to the *Birthday Volume* by H. A. T. Fairbank.



Putti's illustrations of replacement of the lower end of the femur with a graft from the upper end of the tibia after excision of an osteoclastoma. (From the *Birthday Volume.*)

OSTÉO-CHONDRITE VERTÉBRALE INFANTILE

Par Jacques Calvé, M.D.

Surgeon-in-chief, Hôpital franco-américain, Berck-Plage, France

Depuis 1924, où j'ai décrit pour la première fois une affection particulière de la colonne vertébrale chez l'enfant, ***simulant le mal de Pott, individualisée par un syndrome radio-clinique caractéristique,***[1] 7 observations nouvelles, dont une inédite, ont été rapportées sur le même sujet sous la dénomination "*ostéo-chondrite vertébrale*", terme que je proposais moi-même à cause des similitudes que présente cette nouvelle affection avec l'ostéo-chondrite de la hanche et la maladie dite de Koehler. Ceci porte donc à 9, tout au moins à ma connaissance, le nombre des observations d'ostéo-chondrite vertébrale de l'enfant :

1 cas personnel,
1 cas de Brackett, de Boston, } cas déjà publiés dans mon premier travail.
2 cas de Harrenstein, d'Amsterdam,[2]
2 cas de Buchman, de Brooklyn,[3]
1 cas de Kleinberg, cité par Buchman,
1 cas de Gallie, cité par Buchman,
1 cas inédit de Platt, de Manchester.

Syndrome radio-clinique de l'ostéo-chondrite vertébrale infantile

Toutes ces observations sont sensiblement calquées l'une sur l'autre. Il s'agit, en général, d'un enfant de 5 à 10 ans qui, au point de vue clinique, *présente les signes caractéristiques d'un mal de Pott* :

douleur à la pression d'une apophyse épineuse ;
contracture du rachis ;
apparition progressive d'une gibbosité médiane et angulaire ;

Dans 3 cas seulement, la déformation, au lieu d'être médiane, est latérale : *l'enfant est contracturé en position scoliotique.* (Observation de Buchman, observation de Kleinberg cité par Buchman et observation inédite de Platt.)

A *la radiographie*, on trouve, en général, que la lésion frappe *un seul corps*

[1] Calvé, Jacques. "A Localised Affection of the Spine suggesting Osteochondritis of the Vertebral Body with the Clinical Aspects of Pott's Disease," *Jour. Bone and Joint Surg.* vii. 41, Jan. 1925.
[2] Sonderabdruck aus *Zeitschrift für orthopädische Chirurgie*, xlviii. Bd.
[3] *The Journal of Bone and Joint Surg.*, Jan. 1927.

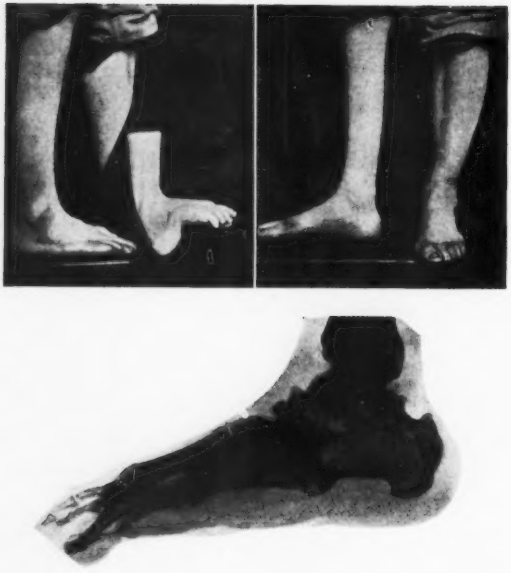
Title page of Calvé's essay contributed to the *Birthday Volume*.

This injury is almost peculiar to athletes, [illegible] epileptics, both of whom are liable to sustain dislocation by direct violence in the manner already described. Most of the former class are powerful, healthy, athletic young men to whom the frequently recurring dislocation from trivial causes is a great and serious disability. In epilepties the dislocation sometimes recurs with every fit. The dislocation is nearly always anterior, rarely posterior.

Some cases have been described in which fractures, either of the anterior margin of the glenoid cavity or of the greater tuberosity of the humerus, have been associated with recurrent dislocation. Such fractures are caused by the direct force which produces the initial dislocation, but they must be regarded as incidental, and not essential, to the recurrent dislocation. The essential feature is the detachment of the capsule from the fibro-cartilaginous glenoid ligament.

The treatment of recurrent dislocation of the shoulder is operative and consists in reattaching the fibrous capsule to the glenoid ligament, or fixing it to the bone at the anterior margin of the glenoid cavity. The operation is as follows:

Extract from A. S. Blundell Bankart's essay on recurrent dislocation of the shoulder joint. (From the *Birthday Volume*.)

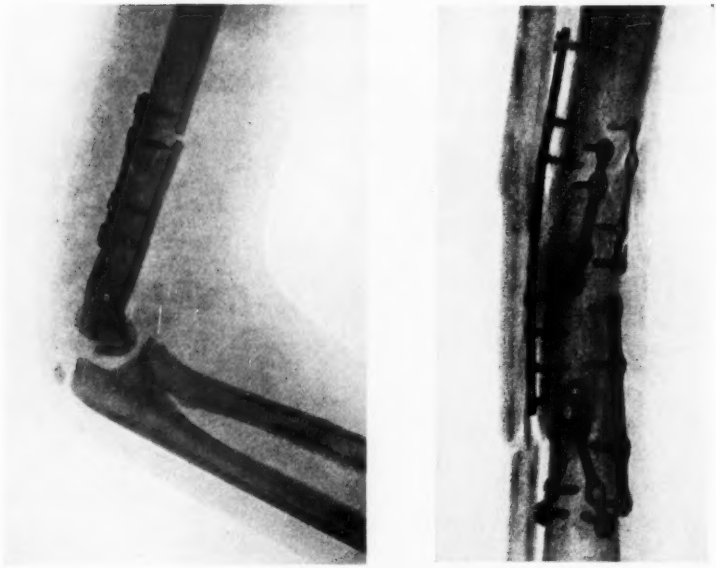


FIGS. 11, 12, and 13.—Case F. M. Cast shows position of foot prior to operation at age of 12. X-ray and photographs eight and a half years later show no recurrence of deformity and the presence of sound mid-tarsal and subastragaloid arthrodesis.

Illustrations from Naughton Dunn's essay on the treatment of foot deformities. (From the *Birthday Volume*.)

Allison and Osgood, one by Clarence Starr of Canada, and others by Putti, Jansen and Calvé from Italy, Holland and France. The preface was by Moynihan and the last chapter was an appreciation of Robert Jones by Lynn-Thomas. The book came as a complete surprise to Jones, who was delighted by it. It was published in 1928 by Humphrey Milford and, although it is rare and was never reprinted, its influence on British orthopaedics has been felt ever since. Oddly enough it is to the European contributions that reference is made most often, for Jansen's essay on " Dissociation of Bone Growth," and Calvé's contribution on " Ostéochondrite Vertébrale Infantile " are still standard essays. The book includes Naughton Dunn's best account of his stabilising operation on the foot, as well as outstanding contributions by Fairbank on infantile coxa vara and by Platt on nerve lesions in elbow injuries.

Arbuthnot Lane—Lane had written on the operative reduction of tibial fractures in 1894. In 1905 he summarised thirteen years' work in *The Operative Treatment of Fractures*—a book of one hundred and forty-four quarto pages in beautiful large-size type, illustrated with surprisingly good radiographs and excellent pictures of the Lane instruments. In 1914 there was a second edition of this volume which laid down principles rather than details. In many ways it is a sad book: if its principles had been appreciated and followed, and indeed if the pages had even been read carefully, the disasters that followed its publication might not have happened. Lane made everything look so easy that his methods were thrown into undeserved disrepute when bad plating produced bad results.



(*Left*) Typical radiograph in Lane's *The Operative Treatment of Fractures* (reproduced here from the second edition, published in 1914 by The Medical Publishing Co. Ltd.), showing a plated fracture of the humerus; note the quality of the radiograph. The right-hand illustration shows the use of an unusually large number of plates for "reposition of the parts" after a comminuted fracture of the tibia.

"Menders of the Maimed"—A major contribution to orthopaedic thought was made in 1919 when the eminent anatomist Arthur Keith published the lectures he had given at the Royal College of Surgeons upon the principles of orthopaedic treatment as laid down by those whom he styled "menders of the maimed." The lectures had already been printed individually but the book was a coherent revision with the subtitle "The Anatomical and Physiological Principles Underlying the Treatment of Injuries to Muscles, Nerves, Bones and Joints." Keith records in his autobiography an early belief that the book would sell well, and his later realisation that on the whole it did not. He attributes some of that failure to the covers, which were of the sort "usually given to heavy monographs on science, and *Menders* certainly does not belong to that class of literature." Still, there was a second edition in 1925. This book really is a classic; it is beautifully written and should be part of the compulsory reading of every young orthopaedic surgeon. Knowledge of its contents would prevent a great deal of useless self-styled research and would steer ideas correctly on the lines of the proper natural history of our art.

Hey Groves—A small book of two hundred and eighty-six pages, published in 1916, should be in the library of every fracture clinic. *On Modern Methods of Treating Fractures* by E. W. Hey Groves has lost little of its original modernity; indeed, if the author had enjoyed the advantages of modern metals he would—as Watson-Jones has reminded us—have gained credit for many techniques that were his conception but impossible in human surgery until

HUGH OWEN THOMAS,
From a sketch made about 1884 when he was in his fiftieth year. He died on 6th January 1891 in his fifty-seventh year.

CHAPTER III

THE PRINCIPLES AND PRACTICE OF HUGH OWEN THOMAS

Hugh Owen Thomas was born when his mother was on a visit to her parents at Bodedern, Anglesey, 23rd August 1834. Her husband, Evan Thomas, was also a native of Anglesey, where his forefathers for many generations had practised as bone-setters. At the time of Hugh's birth his father had established his home in Liverpool, where his fame as a bone-setter had already spread beyond the confines of the city. Hugh was a delicate child, and, on account of his health, was brought up in the country, attending school first in Anglesey, then in St. Asaph, and afterwards, when he lived at home, Dr. Poggi's school, in New Brighton. His professional career may be divided into the three following stages:

35

Page 35 of *Menders of the Maimed*, Arthur Keith. Published in 1919 by the Oxford University Press, Henry Frowde, Hodder and Stoughton.

rustless steel was introduced. This book was an expansion of the Hunterian lectures he gave in 1914 on experimental fractures and their union. The experiments he described included plating, the insertion of steel intramedullary nails and beef-bone pegs, the fixation of fractures by nails and clamps, and most of the " advances " in operative treatment that have been made since.

The British Journal of Surgery—Any mention of Hey Groves leads naturally to the *British Journal of Surgery* which he served so long and so well. This wonderful journal, the best of its kind in the world, published nearly all important British contributions to orthopaedic literature from 1913 to 1947 and until the British volumes of the *Journal of Bone and Joint*

FIG. 140.—Showing the portions of bone removed : *a*, From the astragalus ; *b*, From the scaphoid.

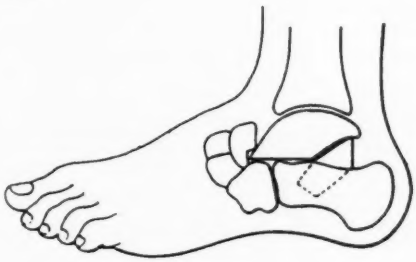


FIG. 141.—Position of the bones after operation.

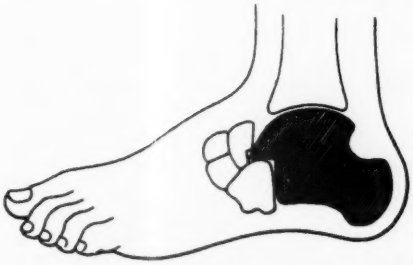


FIG. 142.—Final condition after fusion.

Lambrinudi's pictures from his article on the surgical treatment of drop-foot (*British Journal of Surgery*, 1927, volume 15, page 195). The lines of bone section were modified later.

Surgery began. In many ways, the inevitable loss to the *British Journal of Surgery* implicit in the creation of our own Journal has been a great pity, for orthopaedics had made its mark in the very beginnings of the older journal. Volume I, number 1, appeared in July 1913, with Sir Berkeley Moynihan as chairman of the editorial committee and Hey Groves as editorial secretary. Robert Jones was on the editorial committee. Rickman Godlee's introductory note apologised mildly for the appearance of yet another surgical journal. He should have boasted!

Robert Jones and Alwyn Smith were represented in the first number with their paper on rupture of the crucial ligaments; it includes the classic description of fractures of the tibial

FIBROCYSTIC DISEASE OF THE BONES.

BENIGN CYSTS, OSTEITIS FIBROSA, OSTEITIS FIBROSA WITH FORMATION OF TUMOURS AND GIANT-CELL SARCOMATA (VON RECKLINGHAUSEN), AND MOLLITIES OSSIUM WITH GIANT-CELL SARCOMATA.

By R. C. ELMSLIE, LONDON.

BLOODGOOD, writing upon this subject in 1910, opens his paper with the statement that in many surgical lesions technique is ahead of diagnosis. This statement undoubtedly contains a very important truth. The diagnosis of these obscure bone conditions is difficult, and at present uncertain; to many surgeons the very existence of bone cysts and the allied conditions is actually unknown; and this ignorance has led to the performance of operations of a magnitude which is not justified by the lesion present. In Germany, more particularly, another extreme has been reached. The number of cases placed upon record of bone cysts, osteitis fibrosa, etc., is very great. Each dissertation upon the subject contains, as a rule, an elaborate pathological description of the specimens obtained, and a survey of the literature. But these investigations, valuable as they are, have been largely pathological, and have failed to classify the diseases upon any clinical system; and so they have not led to the record of a clear clinical picture which might assist subsequent observers in making a diagnosis. It is just this clinical picture which is wanting, and which the wealth of material at our disposal ought now to enable us to establish.

FIG. 12.—Radiograph of the humerus of E.O. at the time of the fracture. (*Page* 21.)

The history of solitary cysts of the long bones may be dated from the description in 1877 of a cyst in the upper end of the humerus found by Virchow

British Journal of Surgery, 1914, volume 2, page 17.

42 DISEASE IN BONES

in this connection the diagnostic line which I have described upon several occasions will be found of great value. I append a short description. Any interference with the symmetry of this line should be regarded with apprehension.

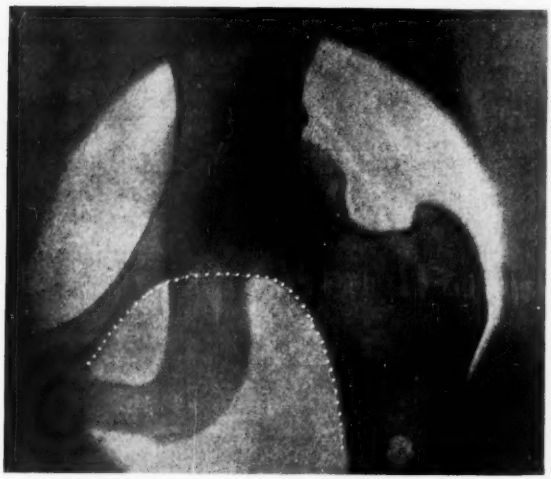


FIG. 28.—A normal hip joint showing the diagnostic line.

This line in all positions of the joint, *i.e.*, abduction, adduction, etc., of the femur, is the same, an unbroken arch formed by the top of the obturator foramen, and the inner side of the femoral neck. Imagination must connect these two lines before a perfect arch is formed, but a glance at Fig. 28 will

Figure 28 from E. W. H. Shenton's *Disease in Bone* (published in 1911 by Macmillan & Co. Ltd.).

spine. In the third number Hey Groves had a sixty-four page article on his experimental work on fractures which was later expanded into his book—there was no shortage of paper then! H. A. T. Fairbank wrote in the fourth number on congenital elevation of the scapula, describing eighteen cases with a beautifully illustrated dissection of a six-week-old patient who had Sprengel's shoulder and died of marasmus. In the second volume there was an important paper by R. C. Elmslie on fibrocystic disease. The unity of benign bone cysts and osteitis fibrosa was emphasized, and though the significance of Askanazy's association of osteitis fibrosa with the parathyroids (recorded in 1904) had been somewhat lost, Elmslie's paper is a classic. The author later had a share in one of the first cases of parathyroidectomy to be performed in this country and this also was reported in the *British Journal of Surgery* (Elmslie *et al.* 1933).

In the same journal appeared Fairbank on " Congenital Dislocation of the Hip " (1922), " Some General Diseases of the Skeleton " (1927), and " Fibrosis of Bone " (1939); Platt on " Pseudocoxalgia " (1922), which was the first British account of this disorder, with reports of thirty-five personal cases and a description of the evolution of the disease; Bankart on " Recurrent Dislocation of the Shoulder " (1938); Lambrinudi on " Drop-foot " (1927); and by R. W. Butler and H. J. Seddon on " Pott's Paraplegia " (1935).

The rest—The other outstanding communications which should be mentioned even in a brief review are largely those of the last ten or fifteen years and they are too recent for fair assessment. H. A. Brittain on ischio-femoral arthrodesis (1941), McMurray on intertrochanteric osteotomy (1936), many papers by Telford and others on cervical ribs and allied problems, Eden's expression of contrary views on the same subject (1939): these and many others must await the verdict of time. One recent book can surely face that judgment with confidence—Watson-Jones's *Fractures and Joint Injuries*, one of the few standard text-books of the English-speaking surgical world which—even in this Journal, which has its author as editor and shares its publisher—must be described as an outstanding credit to both.

Of the authors whose work has been borrowed to illustrate this paper, Sir Thomas Fairbank, Mr A. S. Blundell Bankart and Sir Arthur Keith are still alive and active in the pursuit of their scientific interests. Gratitude is particularly due to them for their kind permission to reproduce extracts from their work.

Most of the illustrations have been taken from published books and periodicals. All sources are mentioned in the captions but the author and the editor wish to record their thanks to publishers and editors who have given permission to reproduce illustrations and extracts. They are: The Editorial Secretary of the *British Journal of Surgery*; Messrs Butterworth & Co.; the Editor of the *Lancet*; the Hon. Editor of the *Liverpool Medico-Chirurgical Journal*; Messrs James Maclehose & Sons; Messrs Macmillan & Co, Ltd.; the Medical Publishing Co. Ltd.; the Oxford University Press; and the Hon. Editor of the *Proceedings of the Royal Society of Medicine*.

REFERENCES

BANKART, A. S. B. (1938): The Pathology and Treatment of Recurrent Dislocation of the Shoulder Joint. British Journal of Surgery, **26,** 23.

BRADFORD, E. H., and LOVETT, R. W. (1890): A Treatise on Orthopedic Surgery. New York: W. Wood & Co.

BRITTAIN, H. A. (1941): Ischio-femoral Arthrodesis. British Journal of Surgery, **29,** 93.

BUTLER, R. W. (1935): Paraplegia in Pott's Disease, with Special Reference to the Pathology and Etiology. British Journal of Surgery, **22,** 738.

EDEN, K. C. (1939): The Vascular Complications of Cervical Ribs. British Journal of Surgery, **27,** 111.

ELMSLIE, R. C. (1914): Fibrocystic Disease of the Bones. British Journal of Surgery, **2,** 17.

ELMSLIE, R. C., FRASER, F. R., DUNHILL, T. P., VICK, R. M., HARRIS, C. F., and DAUPHINEE, J. A. (1933): The Diagnosis and Treatment of Generalised Osteitis Fibrosa with Hyperparathyroidism. British Journal of Surgery, **20,** 479.

FAIRBANK, H. A. T. (1914): Congenital Elevation of the Scapula. British Journal of Surgery, **1,** 553.

FAIRBANK, H. A. T. (1922): Late Results of Treatment of Congenital Dislocations of the Hip. British Journal of Surgery, **10,** 24.

FAIRBANK, H. A. T. (1927): Some General Diseases of the Skeleton. British Journal of Surgery, **15,** 120.

FAIRBANK, H. A. T. (1939): Increased and Decreased Density of Bone with Special Reference to Fibrosis of the Marrow. British Journal of Surgery, **27,** 1.

GROVES, E. W. HEY (1914): An Experimental Study of the Operative Treatment of Fractures. British Journal of Surgery, **1,** 438.
GROVES, E. W. HEY (1916): On Modern Methods of Treating Fractures. Bristol: John Wright & Sons Ltd.
JONES, R. (1910): On Fractures in the Neighbourhood of Joints. Proceedings of the Royal Society of Medicine (Section of Surgery), **4,** 1.
JONES, R. (1915): Injuries of Joints. London: Henry Frowde, Hodder and Stoughton.
JONES, R. (1917): Notes on Military Orthopaedics. London: Cassell & Co. Ltd.
JONES, R. (ed.) (1921): Orthopaedic Surgery of Injuries. By Various Authors. London: Henry Frowde, Hodder and Stoughton.
JONES, R., and LOVETT, R. W. (1923): Orthopaedic Surgery. London: Henry Frowde, Hodder and Stoughton.
JONES, R., and SMITH, S. A. (1913): On Rupture of the Crucial Ligaments of the Knee, and on Fractures of the Spine of the Tibia. British Journal of Surgery, **1,** 70.
THE ROBERT JONES BIRTHDAY VOLUME (1928): London: Humphrey Milford, Oxford University Press.
KEITH, A. (1919): Menders of the Maimed. London: Henry Frowde, Hodder and Stoughton.
LAMBRINUDI, C. (1927): New Operation on Drop-foot. British Journal of Surgery, **15,** 193.
LANE, W. A. (1894): A method of treating Simple Oblique Fractures of the Tibia and Fibula more efficient than those in common use. Transactions of the Clinical Society of London, **27,** 167.
MACEWEN, W. (1912): The Growth of Bone. Glasgow: James Maclehose & Sons.
MACEWEN, W. (1923): On the study of nature as shedding light on the structure and functioning of man: the antler of the deer in its relation to the growth of bone.
MCMURRAY, T. P. (1936): Ununited Fractures of the Neck of the Femur. Journal of Bone and Joint Surgery, **18,** 319.
PLATT, H. (1922): Pseudo-coxalgia. British Journal of Surgery, **9,** 366
SEDDON, H. J. (1935): Pott's Paraplegia: Prognosis and Treatment. British Journal of Surgery, **22,** 769.
TELFORD, E. D., and STOPFORD, J. S. B. (1931): The Vascular Complications of Cervical Rib. British Journal of Surgery, **18,** 557.
TUBBY, A. H. (1896): Deformities. London: Macmillan & Co.
TUBBY, A. H., and JONES, R. (1903): Modern Methods in the Surgery of Paralysis. London: Macmillan & Co.
WATSON, F. (1934): The Life of Sir Robert Jones. London: Hodder and Stoughton Ltd.
WATSON-JONES, R. (1943): Fractures and Joint Injuries. Third edition. Edinburgh: E. & S. Livingstone Ltd.

MEDULLARY NAILING OF FRACTURES AFTER FIFTY YEARS

With a Review of the Difficulties and Complications of the Operation

REGINALD WATSON-JONES, LONDON
J. G. BONNIN, LONDON
THOMAS KING, MELBOURNE
IVAR PALMER, STOCKHOLM
HUGH SMITH, MEMPHIS, TENNESSEE
O. J. VAUGHAN-JACKSON, LONDON
J. CRAWFORD ADAMS, LONDON
H. JACKSON BURROWS, LONDON
E. A. NICOLL, MANSFIELD
FREDERICK VOM SAAL, NEW YORK
DAVID TREVOR, LONDON
A. D. LE VAY, LONDON

At the turn of the half-century surgeons have been inspired by the technique of intramedullary nailing. History will show that in the year 1950 many hundreds and perhaps thousands of case records of nailed fractures were reviewed critically but enthusiastically by surgeons in every part of the world. We ourselves know of the reviews that are taking place in Canada, America, Australia, Sweden, Spain and Great Britain, and there can be little doubt that there are others. No technique has been accepted, after long dormant years, so widely and with more sudden enthusiasm than that of intramedullary pinning of fractures by long nails. A form of internal fixation has been recognised that offers promise not only in the treatment of some recent fractures in which the external support of splints and plaster is minimised, but also in the treatment of fractures with delayed union which are capable of protection for many months without hardship to the patient, fractures with established non-union in which transplantation of iliac bone with medullary nail-fixation is often more satisfactory than onlay grafting with screws and plaster, pathological fractures which can be controlled more easily by this method than by any other, and even perhaps selected open fractures with wounds of soft tissues which may be immobilised—possibly without aggravation of infection—while abscesses are drained, granulating surfaces dressed and skin grafts applied.

Many surgeons believe that the operation is new, whereas it has in fact been developing steadily throughout the last fifty years. Küntscher, whose name is often coupled with the technique, is no more than one of several surgeons who applied it recently in the circumstances of war. Details of the intramedullary fixation of bones were published by Nicolaysen in 1897, Delbet in 1906 and Lambotte in 1913. Delbet practised the internal fixation of fractures of the femoral neck by screws introduced under X-ray control. Lambotte's work was concerned mainly with the fixation of small bone fragments with thin nails; he nailed the neck of the femur (Fig. 1) and used two screws, one in the neck and one down the shaft, for subtrochanteric fractures of the femur (Fig. 2). The use of massive nails which filled the medullary cavity was introduced by Hey Groves (1916, 1918) in England nearly forty years ago. Not only did he experiment with four flanged nails and three flanged nails for fractures of the femoral neck long before Smith-Petersen but he introduced medullary nails through the greater trochanter for fractures of the shaft of the femur (Figs. 3 and 4), through the great tuberosity for fractures of the shaft of the humerus, and through the olecranon for fractures of the shaft of the ulna. He used three types of steel nail: solid nails, nails cruciform in section, and hollow tubes with perforations. He drove nails through the trochanter and across the fracture site into the distal fragment, and also tried the method of retrograde nailing—exposing the fracture site, driving the nail into the medulla of the proximal fragment until it emerged through the trochanter and then, after reducing displacement of the fracture, hammering the nail back into the distal fragment (Fig. 5). His words, written in 1918, may be quoted: " It occurred to me therefore to use a long internal peg or strut such as would render unnecessary

FIG. 1

FIG. 2

Figure 1—Fixation of fractured neck of femur by two nails. Figure 2—Subtrochanteric fracture fixed by a long nail introduced from the greater trochanter and two cross nails. (From Lambotte, *Chirurgie Opératoire des Fractures*, 1913. Paris: Masson et Cie. Reproduced by permission.)

FIG. 3

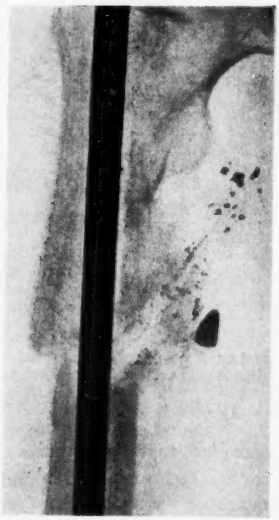


FIG. 4

Figure 3—Fracture of femoral shaft ununited after sixteen months. Figure 4—Fixation by a long steel rod introduced from the top of the great trochanter. (From Hey Groves, in *British Journal of Surgery*, 1918. By permission of the Editor.)

any further fixation and would afford absolute rigidity. I have used pegs of various shapes, cylindrical, cross-sectioned and solid rods, and I am inclined to think that the last named are the best because they give the maximum strength . . . After preparing at least three or four inches of the distal fragment the proximal one is drilled by a special drill 12 inches long. This is driven right up through the trochanter, the top of which is exactly in a line with the axis of the femur. The tip of the drill is made to emerge against the skin of the buttock and then cut down upon. The drill is removed and the peg, 6 to 9 inches long, is then pushed up the proximal fragment until its upper end emerges from the buttock wound and its lower is left about half an inch from the bone end. The two fragments are now brought into apposition and into line, and the peg is hammered down until it engages the lower fragment by several inches."

Many other forms of medullary splint were devised. Some were of metal but others were of ivory, beef bone or human bone (Hoglund 1917). Apart from the fact that they were

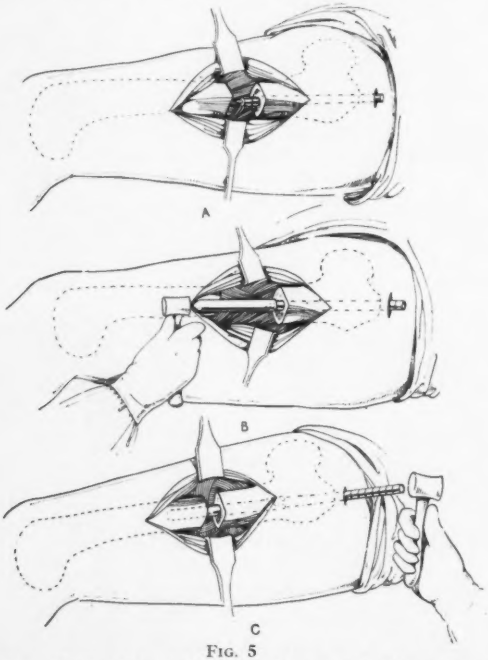


FIG. 5

Hey Groves's method of pegging the shaft of the femur. *A*—A metal rod has been passed upwards from the site of fracture through the top of the great trochanter. *B*—The peg is being pushed up into the upper fragment, driving the rod before it. *C*—Hammering the peg into position. (From Hey Groves's *On Modern Methods of Treating Fractures*, 1921. By courtesy of the publishers, John Wright & Sons Ltd.)

seldom long enough to ensure adequate stability of the fracture they suffered the disadvantage that they were absorbed too quickly for initial fixation to be maintained. When metal was used, however, undesirable tissue reaction often occurred with loosening of the nail. Despite the pioneer work of Arbuthnot Lane (1893) in developing the treatment of fractures by applied plates and screws, metallic internal fixation of bone proved to be unreliable and intramedullary fixation as advocated by Hey Groves was not generally accepted.

Lane had always believed that resorption of bone round plates or screws was a consequence of infection and he declared that " rarefying osteitis in plain English means dirty surgery." The non-touch technique he developed certainly gave him success far beyond that of others,

but bone still reacted to metal by resorption. In 1934 Ménégaux, Odiette and Moÿse suggested that bone resorption might be the result of electrolysis rather than toxicity or infection; three years later Venable, Stuck and Beach (1937) proved that bone was not resorbed if the metal were electrolytically inert. Hey Groves had been defeated by the imperfections of metals available in his time, and it was only after the development of biologically inert alloys such as 18/8 or 18/12 S.Mo steel and "vitallium," and the demonstration thereafter of the successful application of internal fixation to fractures of the neck of the femur by Smith-Petersen, Cave and Vangorder (1931), that interest in intramedullary fixation was revived. But when the merit of such fixation was proved in fractures of the femoral neck it was a simple step to apply it once more to fractures of the shafts of long bones and to explore again the possibility of introducing nails through the greater trochanter, the great tuberosity and the olecranon.

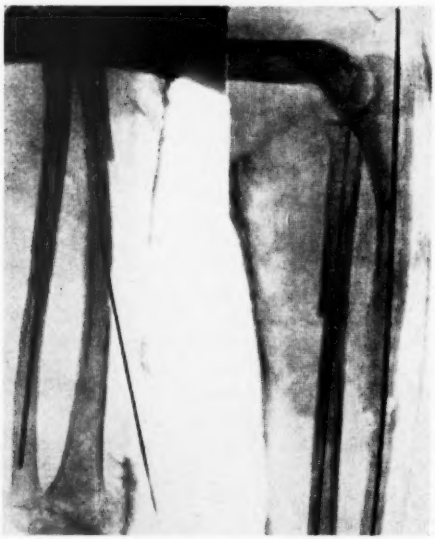


FIG. 6

Intramedullary fixation of radius and ulna by Kirschner wires. (From Lambrinudi, in Proceedings of the Royal Society of Medicine, 1939–40. Reproduced by permission of the Editor.)

Intramedullary fixation by Kirschner wires was advocated in England by Lambrinudi (1940) (Fig. 6) and in Belgium by Danis (quoted by Soeur 1946). Steinman pins were driven into the medulla of long bones in America by Rush (1939). But these methods were never mechanically efficient (Watson-Jones 1943) and it was not until wide nails—fully engaging the medulla of the bone—were reintroduced in the Finnish war of 1942, that the technique commanded respect. In Europe it was seized upon with enthusiasm during the second world war when patients were necessarily discharged from hospital as quickly as possible. Moreover, in so far as intramedullary fixation was possible without operative exposure of the fracture, the technique of blind nailing was developed in an attempt to avoid the dangers of bone infection, which had been aggravated by lack of suitable hospital facilities and good nursing. Böhler, whose treatment of fractures has always been dominated by the fear of infection after operative exposure, became an enthusiastic exponent of blind intramedullary nailing

under fluoroscopic control. He devoted the whole of one volume of his *Treatment of Fractures* to this method and although admitting that the procedure might go on for several hours, he said: "In fresh closed fractures open medullary nailing should not be performed because the risk of infection is very great . . . If this is done the greatest advantage of the closed medullary nailing, *viz.*, minimisation of the danger of infection, the most precious virtue of the Küntscher method, is lost."

The wide application of intramedullary nailing as used in Germany has been reported to us by Le Vay who visited the Schleswig Clinic of Professor Küntscher in 1948 and studied the work of his colleagues at the University Hospital of Kiel.

INTRAMEDULLARY NAILING IN THE KÜNTSCHER CLINIC

A. D. Le Vay, London, England

In Germany intramedullary nailing of fresh fractures is the routine treatment in many large hospitals. It is regarded as the best method available for providing maximal function and at the same time maximal fixation; Küntscher believes that in adults every closed fracture of a long bone, and indeed many compound fractures, should be nailed. He argues that since the nail lies in a longitudinal axis all shearing strains acting at the fracture site are converted into compression forces. The only absolute contra-indication is existing sepsis such as a boil or carbuncle, or poor general condition. Nailing is seldom used in children for here there is no economic urgency and no danger of non-union or stiffness despite long immobilisation. Only two children with nails were to be seen at Schleswig. One was a girl with osteogenesis imperfecta whose femora had been nailed as a protection against further fractures. The other child had a fractured femur in a limb so atrophied after poliomyelitis that delayed union was feared.

Küntscher used only closed methods for nailing simple fractures, the nail being introduced through a small incision at one end of the bone under intermittent fluoroscopic control. If closed methods failed, the operation was abandoned in favour of traction or plaster. He was entirely opposed to exposure of the fragments at the site of fracture with direct or retrograde nailing as practised by other surgeons. The main types of nail used were straight ones, trefoil in cross-section for the femur and humerus (Fig. 7) and double-spread nails for the tibia designed to engage the expanded lower end of the bone (Fig. 8).

Infection appeared to occur in about 5 per cent of cases but was not necessarily regarded as a disaster. It was believed that if the nail were left in place it acted as a drain carrying pus to the surface and that by immobilising the bone it limited the inflammatory process. All that was then needed was drainage of the soft tissues at the site of introduction of the nail and possibly also at the fracture site.

Nailing fractures of the femoral shaft—In nailing the femoral shaft the patient was placed on the sound side with both hips flexed to a right angle against a short post at the groins, the fractured limb lying uppermost and being fixed to a traction stirrup. In this way the greater trochanter was thrown clear of the wing of the ilium which obstructs the insertion of a nail in conventional positions. The writer was impressed by the fact that once the necessary skill and experience had been acquired the insertion of a nail seemed to be a trivial procedure, often carried out by a surgeon single-handed with the help of the theatre sister. The shortage of equipment at that time was such that only the surgeon wore gloves, the sister handling all instruments and the nails themselves. Reduction was checked with two portable X-ray machines equipped for fluorescent screening. In the course of one operation attended by the writer there were twelve screenings, each lasting from two to five seconds; although this was more than usual it seemed plain that even with every precaution such casual screening would not be accepted in Great Britain. The risk of sepsis attendant

on the repeatedly dimmed lights and the manoeuvring of X-ray machines also seemed to be very real.

Intramedullary nailing for trochanteric fractures—For trochanteric fractures of the femur a " signal arm " arrangement of two interlocking pins was used and there was a great contrast between the mass of metal introduced and the two tiny incisions needed. The smaller cross-pin was sited with the help of an external guide (Fig. 9). The patient was allowed to walk within fourteen days. The Smith-Petersen pin has been abandoned for medial fractures of the femoral neck, a simple U-section nail being introduced almost vertically by feel alone, from a point well down the shaft, after a radiographic check of reduction. By aiming at continuous impingement against the opposite cortex from below upwards, central nailing was said to result automatically, and so prevent the need for either repeated

FIG. 7
Trefoil-section nail for femur and humerus.

FIG. 8
Double-spread nail for tibia.

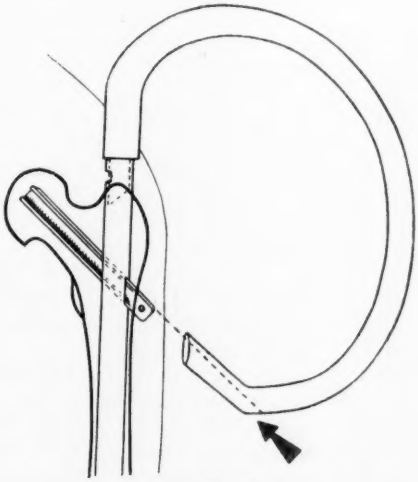


FIG. 9
" Signal arm " nails for trochanteric fractures. Note external guide for siting of the smaller nail.

radiographs or many nails of different length. Over-reduction, with a good ledge of neck supporting the head fragment, seemed to be a feature of these cases.

Nailing infected fractures with delayed union—There were very many cases of delayed union and pseudarthrosis of the femur and tibia after war injuries. Some had been nailed even in the presence of sinuses. Union was often secured, sometimes with persisting sinuses, but even then the gain was considerable because patients could walk without splints and mobilise adjacent joints. There was quite often a flare of infection after nailing but drainage paths already existed and—with the cover of penicillin—the risk did not seem to be great. Old compound fractures were never nailed until the temperature and sedimentation rate had been normal for some time. Sequestration sometimes occurred. One patient had a sliver of dead bone alongside the nail and well above the healed fracture in a quite inaccessible position.

Intramedullary nailing for pseudarthrosis—Nailing was regarded as the treatment of choice for pseudarthrosis; bone-grafting was done seldom. In the upper limb the bone was shortened to allow adequate freshening of the bone ends. In the forearm it was necessary

to shorten both bones and to nail them both even when the fracture involved only one bone. No external immobilisation or splintage of any kind was used after nailing.

Intramedullary nailing for arthrodesis and osteotomy—Intramedullary fixation was sometimes used after arthrodesis or osteotomy. The method has perhaps reached its height of ingenuity in arthrodesis of the knee joint. At the first operation a nail measuring thirty inches in length—an awesome weapon, seen for the first time—was inserted through the usual stab incision over the greater trochanter and passed through the femur, across the knee joint and down the tibia to just above the ankle (Fig. 10). A curved nail was preferred because it permitted some flexion at the knee. The patient was allowed up within a week or two. At a second-stage operation a chisel was inserted through short incisions at the medial and lateral sides of the knee and the articular surfaces were broken up thoroughly. The patient continued to walk "on the nail," which might be removed when fusion was sound. This long nail also proved valuable for the control of long-standing flexion deformity of the knee joint after prolonged bed-rest or in patients with rheumatoid arthritis. The flexion deformity was corrected by supracondylar osteotomy with immediate immobilisation by a nail passed across the joint.

FIG. 10
Fixation by a long nail after arthrodesis of the knee.

For arthrodesis of the ankle joint a large tapering nail was inserted through the foot from below, traversing the calcaneum and talus. The second stage, as in the knee, consisted of blind destruction of the joint surfaces, but a drawback here was that the subtalar joint was left damaged by the passage of the nail or was of necessity also arthrodesed. In arthrodesis of the shoulder joint a "shepherd's crook" nail gripped the spine of the scapula and passed into the shaft of the humerus. Nailing was also employed after bone-shortening and bone-lengthening operations and in the treatment of pathological fractures of long bones from metastatic deposits.

General impressions of Küntscher's technique—It was clear that Küntscher disliked extensive open bone operations or any disturbance of the periosteum, and he stated that every such intervention delayed healing; he believed that the advantage of closed nailing lay in the avoidance of such disturbance and the fact that surgical intervention could be limited. All his procedures reflected this attitude—refusal to expose a simple fracture for nailing, avoidance of bone-grafting operations, dislike of plates and screws, and his very limited approach for arthrodesis of the knee joint. One was bound to conclude that such methods were evolved under the pressure of circumstances—the shortage of skilled nurses, the lack of penicillin, the need for immediate fixation without plaster and, above all, the total lack of certainty as to the duration of post-operative stay in hospital determined by the doubtful number of hospital beds that would be available. A virtue was made of necessity.

THE MERIT OF INTRAMEDULLARY FIXATION

In other parts of the world there has been less fear of operative exposure of the fracture and most surgeons have reverted to the technique of Hey Groves and introduced medullary nails under visual control, either by the direct method or by the technique of retrograde nailing. The very great merit claimed for medullary nailing is that the internal fixation is so much more efficient than that of circumferential wire, encircling bands, or plates and screws. The length of the nail controls angulation and the width immobilises the fragments without perforation of the bone cortex by screws and the consequent risk of secondary fracture; at the same time even massive nails can be removed easily at secondary operations through a two- or three-inch incision. In fractures of the upper shaft of the femur—which have always presented difficulty when treated conservatively—the technique has found one

of its most useful applications. Displacement of the fragments is controlled easily and protection can be maintained for long periods so that lateral angulation—which often occurred formerly during the third or fourth months—is prevented. The long nail can safely be left in the bone so that fractures with slow and delayed union consolidate without the hardship of plaster spicas or the annoyance of walking calipers. Malunited fractures and fractures with established non-union may be treated successfully by freshening and replacement of the bone ends, insertion of iliac bone chips and intramedullary fixation—usually with the added protection of a plaster spica for the first two or three months. In some pathological fractures of the femur, intramedullary nailing is the solution to the former problem of best giving comfort during the patient's often brief survival.

FIG. 11

FIG. 12

Figure 11—Established non-union thirteen years after fracture of the humerus. Figure 12—Sound bone union ten months after freshening of the fracture surfaces, fixation by intramedullary nail and placing of iliac bone chips around the fracture.

In many other fractures the technique has solved difficult problems. Internal fixation of the fractured ulna in Monteggia fracture-dislocations, and of the fragments of a fractured humerus, particularly in cases of delayed union and non-union, are examples (Figs. 11 and 12). Displaced fractures of the neck of the humerus have been treated more easily than by some conservative means. The method has also been used for fractures of the shaft of the tibia, and for fractures of both bones of the forearm, although with much less certainty.

During the last few months this Journal has received from widely scattered sources many accounts of the complications of intramedullary nailing and the reports have been collated in this review. Nearly every writer in recording the complications has at the same time shown enthusiasm for the technique, and the contributions are valuable not only in reminding us of the difficulties but in suggesting how they may be overcome. Ivar Palmer of Sweden, whose review appears on page 721, has written of the difficulties and complications of

intramedullary nailing with some hesitancy because " it is not pleasant to speak only of the faults of a dear friend." Hugh Smith (1950) in presenting the report of the Committee on Fractures and Traumatic Surgery of the American Academy of Orthopaedic Surgeons wrote: " With experience we have become less timid and have applied intramedullary fixation to a great array of interesting lesions of the femur—namely, fresh fractures, cases of delayed union or non union, the bridging of defects, fractures through pathological bone in Paget's disease, dysplasia or extreme osteoporosis, and osteotomies to correct bowing of the femora from various pathological entities. As from January 1, 1950, 398 intramedullary pins have been inserted. To say that the results to date are encouraging would be an underestimate . . . For those who may be uncertain about proceeding with this technique we offer the following statement—given the proper indications, intramedullary fixation is the most effective form of therapy for many fractures of the shaft of the femur. That statement must now be modified a bit. *This technique if applied to improperly selected cases, or if inefficiently or unskilfully carried out, offers more possibilities of trouble than any other.*"

Within the next few years there will almost certainly be increasing enthusiasm for the treatment of fractures by intramedullary fixation, and surgeons in many parts of the world will look to this operation for the solution of many problems. It is hoped that perusal of these case reports will emphasize that the operation is not always a simple procedure occupying ten or fifteen minutes; that sometimes it has demanded more than four hours of perilous anxiety; and that complications have arisen which have called for all the resources at the command of experienced surgeons. Thomas King of Melbourne writes: " Internal fixation introduces some special complications such as bending or breaking of plates, and the Küntscher nail has a formidable list of complications. They include severe shock from hammering in a nail that fits too tightly in the medullary cavity, penetration of the bone and severance of the popliteal artery or sciatic nerve, splitting of the femur which means that the operation must be abandoned, and infection of the medullary cavity which is said to occur in 5 per cent of cases. In studying the case histories of more than 600 cases placed at my disposal at various hospitals I found an unbelievable number of complications."

The special purpose of this review is not to press the claims of medullary nailing but, on the contrary, to indicate the difficulties that often arise and to warn surgeons in advance of the dangers that may beset them.

DANGERS OF MEDULLARY NAILING BY THE CLOSED METHOD

The technique of intramedullary nailing of fractures by the closed or blind method under fluoroscopic control was developed by Küntscher in circumstances of war when " a virtue was made of necessity." Le Vay refers to the dangers of X-ray screening which as practised in Germany " would not be accepted in Great Britain." We must indeed wonder how soon it will be before these surgeons or their assistants suffer amputation of the fingers or X-ray gangrene of the nose. Le Vay speaks also of the risk of sepsis from repeated dimming of lights and the manoeuvring of X-ray machines in the region of the wound. But true as it is that many radiographic screenings in the treatment of a single fracture would never be accepted in Great Britain or America, where the tragedies of X-ray burns of the hands and face are well known, the dangers of blind insertion of nails are at least as great to the patient as to the surgeon. We have heard of many disasters arising from attempts to nail fractures of the shaft of a long bone by the closed technique.

Missing the distal fragment in fractures of the femoral shaft—In a personal communication, Austin T. Moore (Columbia, South Carolina) describes the case of an elderly diabetic woman whose fracture was so little displaced as to appear to lend itself to blind nailing. Through a small incision the trochanteric fossa was located quickly and there was no trouble in driving a nail down the shaft. The resistance of the fracture line was encountered and then, with ease, the nail was felt to be driven on. Clinically the fracture appeared to be

immobilised completely. The surgeon as well as his assistants "smiled at the ease of the procedure," but when the radiographs came back they found to their chagrin that the nail was lying along the outer side of the lower fragment. The nail was withdrawn and reintroduced after exposure of the fracture.

Severing the femoral artery—The significant part of Austin Moore's communication is that he goes on to write: "Visiting a neighbouring hospital the following week I learned of a similar experience in an operation on a fractured humerus. I have since heard of a case where the nail missed the lower femoral fragment and divided the femoral artery. I have come to the conclusion that I will expose the fracture site in all cases in the future."

This is not the only case that has occurred of contusion or division of the femoral artery by the point of an intramedullary nail introduced blindly, even under fluoroscopic control. We know that other femoral arteries have been injured and that limbs have been amputated, but we have not yet been given permission to publish the details of these cases.

Injury to the radial nerve—Blind nailing is also dangerous in fractures of the shaft of the humerus where the radial nerve lies so close to the bone that it may be contused or severed. Palmer records two cases of injury to the radial nerve. In one fracture of the neck of the humerus a nail was introduced in retrograde direction through a hole in the shaft at the level of the deltoid insertion, but the nail penetrated the medial wall of the distal fragment and caused radial palsy. The other case was a fracture of the shaft of the humerus in which the nail took the wrong direction and made its way out into the soft parts at the level of the fracture. Injury to the radial nerve caused temporary paralysis.

Summary of the dangers of blind nailing—The dangers of nailing by the subcutaneous approach under fluoroscopic control include X-ray burns to the hands and face of the surgeon and his assistants, failure to engage the distal fragment of the fractured bone and injury to the main blood vessels and nerves of the limb. Palmer has independently reached almost identical conclusions from the analysis of **164** fractures treated by intramedullary nailing which he has contributed to this symposium. F. vom Saal of New York wrote a covering note to his invited contribution: "I hope that the necessity for open reduction of fractures before attempting the introduction of a nail has been emphasized sufficiently in this manuscript. Most of the complications could not have occurred with open operations." The consensus in Britain and America is that blind nailing is dangerous and that intramedullary nailing should be attempted only with direct visual control by exposure of the fracture, supplemented by the evidence of X-ray films but not of fluoroscopic screening.

IMPACTION OF THE NAIL IN ONE OF THE BONE FRAGMENTS

What is a surgeon to do when half of a twelve-inch nail is sticking out through a wound and the other half is impacted so tightly that it can neither be driven farther into the bone nor be extracted from it? This is the situation with which many surgeons in all parts of the world have been faced in recent years. Böhler, in his book *Medullary Nailing of Küntscher* (1948), entitled one section: "How to proceed if a medullary nail can be neither driven in farther nor removed." Warren White of Greenville, South Carolina, in discussing a paper by Street (1950), said: "Any surgeon who has inserted a Küntscher nail and has not been able to pull it out has found himself in an embarrassing situation"; and the comment of Eaton of Baltimore was: "the use of too wide a nail may come close to being an unforgettable experience." These American comments show that the British are not alone in understatement. How embarrassing and how unforgettable the experience may be is illustrated in the reports published in this review; they include one in which there was not only impaction of a nail projecting through a wound in the trochanteric region but also impaction of a guide wire projecting through a second wound in the thigh—and neither nail nor guide wire could be moved! When was embarrassment greater? It will be agreed at once that surgeons should not only take careful pre-operative measurements of the medullary canal but that operations

for intramedullary nailing should not be embarked upon until a sterilized hacksaw is on the instrument table, ready for use.

Impaction in the shaft of the femur of a nail introduced from the fracture site—O. J. VAUGHAN-JACKSON (London, England). A woman aged thirty-two years sustained a transverse fracture of the mid-shaft of the right femur (Fig. 13) and fixation by an intramedullary nail was undertaken four days after the accident. Closed nailing was attempted and the first difficulty encountered. The guide wire, introduced at the upper end of the shaft, just medial to the tip of the greater trochanter, impinged against the inner cortex of the femur at the level of the lesser trochanter; despite repeated withdrawal and reinsertion it continued obstinately to follow its first path and impinge against the inner cortex of the femur. After much time had been spent in these unsuccessful attempts it was decided to expose the fracture site and pass the nail up the medullary cavity of the proximal fragment. The fracture was exposed and the blunt end of the nail was inserted and driven into the proximal fragment; but the nail was just too large for the medullary cavity and

FIG. 13

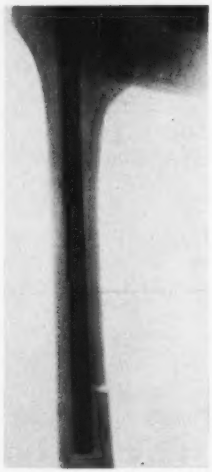


FIG. 14

Transverse fracture of the shaft of the femur before nailing (Fig. 13). Note the unusually narrow medullary cavity in the lower half of the upper fragment. Nailing was complicated by jamming of the nail in the upper fragment. To avoid excessive hammering in a shocked patient the lower part of the nail was sawn off and the stump manipulated into the distal fragment (Fig. 14).

it jammed very firmly. The slot for gripping the nail with the extractor was of course inaccessible and all efforts at removal failed. Renewed efforts were therefore made to drive the nail on. With further heavy hammering the nail was driven upwards until its upper end was in the trochanteric region. The anaesthetist then announced an alarming fall in the patient's blood pressure. Fully half the length of the nail was still projecting through the wound at the fracture site. In these urgent circumstances, although no suitable instrument was available in the theatre, a hacksaw was obtained hastily from the workshops and sterilized; the end of the nail was cut off, leaving a short stub one and a half inches long which was manipulated into the medullary cavity of the distal fragment (Fig. 14). Apposition was thus ensured, and after closure of the wound the limb was placed in a Thomas's splint with skin traction.

Comment—Retrograde insertion of a medullary nail from the fracture site is a practicable and reasonable procedure. The modified nail designed by Burns is easier to insert in this

manner than standard nails but it is by no means indispensable. The primary mistake which led to all the trouble in the case described above was the failure to appreciate from the radiographs that in this slightly-built woman the medullary canal of the femur was unusually narrow. It is suggested therefore that if radiographs show a narrow medullary cavity, it would be a useful precaution to have an antero-posterior radiograph of the fractured bone with the selected nail strapped temporarily to the side of the limb. The magnification of the medullary cavity and of the nail would be approximately equal and measurements on the radiographs of their relative widths would indicate whether or not the nail would pass easily.

Impaction of a nail in the sclerotic bone of a fractured femur in Paget's disease—E. A. NICOLL (Mansfield, England). A patient suffering from Paget's disease sustained a spontaneous fracture of the upper third of the femur (Fig. 15). She had the typical flexion-abduction displacement of the upper fragment which is so difficult to control and which in normal circumstances is an indication for open reduction and intramedullary nailing. It

FIG. 15

FIG. 16

Figure 15—Fracture of upper third of femoral shaft complicating Paget's disease. Medullary nailing was attempted but it proved impossible to drive the nail through the dense bone of the upper fragment. The nail became firmly impacted and great difficulty was experienced in removing it. The fracture united with some angulation after fixation with an oblique screw (Fig. 16).

was decided to adopt this procedure and the open reduction proved quite simple. The nail was then introduced from above and was driven about an inch into the trochanter with some difficulty; it then jammed and after another five minutes of redoubled effort the nail had advanced about a quarter of an inch. Further efforts were evidently doomed to failure and were only making retreat more difficult. The nail, it was decided, should be taken out. This took half an hour and several extracting instruments were broken in the process. The fracture was finally fixed by a single oblique screw (Fig. 16), and fortunately the patient made a good recovery with no ill-effects from so much unnecessary trauma.

Comment—This case and another reported below, of a nail impacted in a fractured tibia, illustrate the difficulties caused by failure to understand that it is impossible to drive a blunt nail through sclerotic bone. When pre-operative radiographs indicate dense sclerosis encroaching on the medullary cavity, either in old fractures or in pathological conditions of the skeleton, intramedullary nailing should not be attempted.

Impaction in the shaft of the femur of a nail introduced through the trochanter—*and later impaction of both a nail and a guide wire, the nail projecting through a wound over the trochanter and the wire through a wound in the thigh*—Report by HUGH SMITH (Memphis, Tennessee)—A patient aged twenty-five years sustained a transverse fracture of the upper shaft of the femur which was considered suitable for intramedullary fixation (Fig. 17). It was presumed that the intramedullary canal of an average adult would receive an eleven-millimetre nail without difficulty and a Hansen-Street diamond-section nail of this diameter was passed down the intramedullary canal from above. At twelve centimetres resistance was met. Every attempt, to drive the nail through the area of impingement was of no avail and it was decided to extract it. In this attempt all hooks on the extraction apparatus were quickly broken. A Steinmann pin was placed through the eye of the nail but the eye pulled open. An inlay driven into the medullary canal from below failed to dislodge the nail. Workshop equipment including a pair of vice-grip pliers was used and after great difficulty the nail was extracted. The operating time till then was two hours; blood pressure 130/86; pulse 84.

A review of the radiographs showed that the diameter of the canal diminished in a length of twelve centimetres of the proximal fragment. It was decided to use a narrower nail guided by a wire introduced through the fracture site and threaded backwards to the trochanter. Accordingly a guide wire was passed in retrograde direction through the proximal fragment and out through the upper wound. A nine-millimetre nail was threaded over it and driven into the bone. Very quickly it became impacted solidly in the femur and was compressed so powerfully that it also gripped the guide wire. We were then faced with the problem of a nail projecting through the proximal wound which we could neither drive on nor extract, and a guide wire projecting through the distal wound which we could not move. The trials and tribulations of the next hour and a half need not be detailed. Much equipment was wrecked but ultimately the nail and the guide wire were removed. The anaesthesia time was then three and a half hours; blood pressure 120/80; pulse 96; general condition remarkably good.

As the condition of the patient was so good and our endeavour had not yet been achieved, we went on to widen the medullary canal. By working from each end of the proximal fragment with a nine-millimetre burr we prepared a track through which a nail of similar diameter was inserted (Figs. 18, 19). The operation of intramedullary nailing was concluded successfully after four hours and fifty minutes.

Comment—Since this disastrous case we have done many intramedullary nailings of the femur without embarrassment of impacted nails. Measurement of the intramedullary canal in relation to the nail is made on the opposite femur by strapping a Küntscher nail on the lateral aspect of the thigh and taking radiographs on two films with a film distance of forty inches, from which the correct length and diameter of the nail can be calculated with some degree of accuracy. Nails in a much wider range of diameters are now made available before any operation is attempted, and include diameters from 7 to 11 millimetres. Moreover, care is always taken that perceptible progress is surely made with each blow of the hammer. If there is any sign of impaction the nail is at once withdrawn and exchanged for one of smaller diameter. In order to avoid gripping of the guide wire by the nail the wire is extracted as soon as the nail fully engages the intramedullary canal. Finally, special clamps with vice-grip pliers have been devised which are sufficiently strong to extract an impacted nail.

Pre-operative measurement of the intramedullary canal, and enlargement of the canal by reamers—In a recent personal note Hugh Smith reports that his own experience now includes some forty-five intramedullary nails for the femur; in reviewing the work of twenty-two investigators he has knowledge of well over 450 cases of nails in the femur. A more elaborate and accurate plan of measuring intramedullary canals has now been devised. In his report to the American Academy of Orthopaedic Surgeons (1950) he writes: " There is no formula for determining

the size of the canal in relation to the length of the bone. In general, young athletic individuals with very large bones usually have rather small canals—as little as 6 or 7 millimetres in diameter at the isthmus in the middle and upper thirds. The thick cortices encroach upon the canal. A small elderly woman, on the other hand, may have a very large intramedullary canal so that even an 11-millimetre pin may provide insecure fixation . . . Consultation with the Committee on Roentgenology of the National Research Council failed to divulge any very accurate method of determining the proper pre-operative measurement for the pins. The most accurate technique consists of a scanogram—that is, a full-length detailed picture of the normal femur—with a pin of known diameter and length strapped to the thigh parallel to the shaft of the bone . . . As an added precaution, after exposure of the fragments, reamers, 9, 10 and 11 millimetres diameter, can be introduced proximally and distally into the intramedullary canal. If the canal is not sufficiently large to take a reamer of the desired diameter it can be reamed out until it is so . . . No local or general untoward effects have been noted as a result of this method of enlarging the canal. A clearance of 1 millimetre provides a very tight fit; a clearance of 2 millimetres provides a medium fit."

FIG. 17

FIG. 18

FIG. 19

Transverse fracture of femur before nailing (Fig. 17). Note narrow intramedullary canal (8 millimetres) of proximal fragment. Figures 18 and 19 show radiographic appearance one day after operation. Narrow canal was enlarged to 9 millimetres before an intramedullary nail could be introduced. The fracture united within three months.

Impaction of an intramedullary nail in the sclerotic bone of a fractured tibia—E. A. NICOLL (Mansfield, England). In June 1948 a man aged forty-six years was admitted with an open fracture of the tibia and fibula with considerable skin loss which was replaced by split-skin grafting. Although the fracture was accurately reduced and was immobilised for eight months it failed to unite (Fig. 20). In normal circumstances a bone graft would have been performed at this stage, but before this could have been undertaken with safety, it would have been necessary to replace the split-skin graft by a pedicle flap. This procedure, together with the subsequent bone graft, would have meant two major operations and a

further twenty weeks' fixation in a man whose knee was already stiff. As the skin over the upper end of the tibia was normal it was decided instead to introduce an intramedullary nail and start mobilisation at once. This operation was done in about ten minutes without any difficulty. At six weeks the patient was able to walk without pain and he had a good range of knee movement; in three months he was back working full time (as a gardener) and had recovered almost normal movement of the knee. Recent radiographs show a well-united fracture (Fig. 21).

A few months later a similar problem was encountered (Fig. 22); in view of the success of the first case, it was decided to adopt the same procedure. The nail was driven along the medullary cavity without difficulty until it reached the level of the fracture. At this stage it jammed; no amount of hammering would induce it to go farther, nor could it be extracted; and in spite of reluctance to expose the fracture through a split-skin graft, there was finally no alternative. When this had been done the reason of the difficulty was at once appreciated: the lower cortex of the upper fragment was very sclerotic and encroached upon the medullary cavity. The point at which the nail was jammed had to be exposed by removing the overlying cortex and cutting a channel through which it could be guided into the lower fragment. In spite of forebodings the wound healed by first intention. All pain disappeared, recovery was complete and the patient went back to his work as a miner (Fig. 23). It is obvious that had the significance of the sclerosis been appreciated the considerable difficulty encountered at operation might have been foreseen and the whole plan of treatment altered.

Other cases of impaction—Further examples of impaction of a nail in the femur, tibia or humerus are reported by Palmer and by vom Saal in their independent reviews included in this symposium. In one of Palmer's cases the femur was split during a stubborn attempt to drive in too coarse a nail (page 723). In another case of fracture of the humerus impaction led to distraction of the fragments with delayed union (page 727). In vom Saal's case also, impaction of the nail was associated with distraction of the fragments, and contact was restored only after very considerable difficulty (Fig. 49, page 720).

Summary of the complications arising from impaction of medullary nails—Impaction of a nail so that it cannot be driven farther into the bone or be extracted from it presents very great difficulty. Forcible hammering may shatter the bone and cause myositis ossificans; and if the nail has already passed the site of fracture the fragments may be distracted and union delayed. It is therefore better to use every device for extraction of the nail with the object of introducing one of narrower dimension; then if these efforts fail, to saw off the projecting part. If the nail has been introduced in retrograde direction from the fracture site a short projecting stub should be left so that it can be angulated into the distal fragment and some fixation, however imperfect, be gained.

EXTRUSION OF INTRAMEDULLARY NAILS FROM THE BONE

Extrusion of three-flanged nails used for the fixation of fractures of the femoral neck has been attributed by many surgeons to resorption of bone at the site of fracture with consequent impaction of the fragments. It has often been claimed that such extrusion should not be prevented by the use of a cross-pin in the trochanteric region because impaction of the fragments was inevitable and if the nail were fixed in the distal fragment it would perforate the proximal fragment and enter the joint. Some of us have doubted this explanation. Penetration of the head of the femur by a nail occurs only when the bone is dead, and in these circumstances it occurs whether the nail is fixed by a cross-pin or not. Moreover, continued resorption of bone in the region of any fracture does not occur if there is complete immobility of the fragments. Finally, the length of nail extruded from the neck of the femur through the trochanter was often far greater than could be explained by the degree of resorption and impaction of the fragments. It has seemed more likely that extrusion was a positive expulsion, perhaps arising from the pressure of products of ionisation and foreign body

FIG. 20

FIG. 21

Delayed union of a fractured tibia treated successfully by intramedullary nailing.

FIG. 22

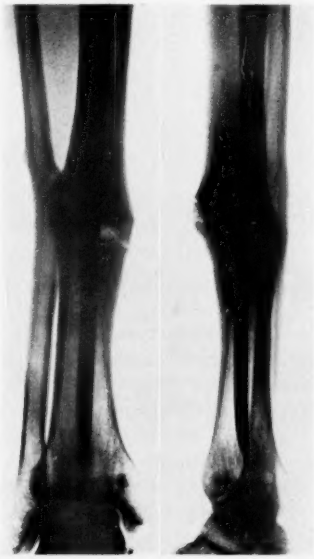


FIG. 23

Figure 22—A similar problem to that shown in Figure 20. But when the nail had reached the site of fracture it could not be driven farther because of dense sclerosis. Efforts to extract the nail were unsuccessful and it was necessary to expose the fracture and cut a channel for the nail before it could be driven across the fracture. Figure 23 shows radiographs at the conclusion of treatment.

reaction accumulating between the nail and the bone. Certainly experience of intramedullary nailing of shaft fractures has shown that when a nail is extruded the length of metal expelled has no relationship at all to the impaction of fragments. In one case, personally communicated, a patient whose fracture of the shaft of the femur had been immobilised by a nail driven through the trochanter complained after several weeks of pain in his chest; it was found that the proximal end of the extruded nail was impinging against the ribs!

Extrusion of intramedullary nail from the femur—REGINALD WATSON-JONES (London, England). A man aged forty-seven years fell through a garage roof and sustained a comminuted fracture of the upper third of the shaft of the femur which was treated by immobilisation in a Thomas's splint with skin traction. After fifteen weeks, clinical tests suggested that union was sound enough to begin non-weight-bearing exercise and the splint

FIG. 24

FIG. 25

FIG. 26

Figure 24—Immediately after nailing. Figure 25—Radiograph two months later showed extrusion of nail. Figure 26—Nail hammered back and fixed with cross-screw.

was removed; but two weeks later it was evident that union was not consolidated and the fragments were bowing outwards. Instead of reapplying the Thomas's splint or immobilising the limb in a plaster spica an intramedullary nail was introduced through the trochanter (Fig. 24). Bed exercises were continued and weight-bearing was allowed after four weeks. After two months the patient complained of discomfort in the trochanteric region where the end of the nail could be felt; and after three months the pain was so severe that he was unable to walk. Serial radiographs showed progressive extrusion of the nail (Fig. 25). A short incision was made above the trochanter and when the scar tissue over the extruded nail was divided there was a spurt of clear, free fluid which was obviously under pressure. The nail was hammered back into the bone and a two-inch screw was driven through it (via a machine-drilled hole) at right angles to its long axis, into the lower part of the femoral neck (Fig. 26). Weight-bearing was then continued and the fracture consolidated soundly in good alignment. No further trouble

has arisen although five years have now elapsed, and the nail and cross-screw are still in the bone.

Extrusion of medullary nail from the humerus with impingement against the acromion—REGINALD WATSON-JONES (London, England). In 1947 a woman aged thirty-six years came to England from Israel with a fracture of the shaft of the humerus still ununited after thirteen years. So many operations had been performed that the patient had lost count of them; she thought that there had probably been sixteen, but was sure that seven bone-grafting procedures had been carried out with transplantation from both tibiae, one femur and both sides of the pelvis. All these operations had failed and there was a freely mobile pseudarthrosis of the lower shaft of the humerus with only 10 degrees of movement of the elbow joint and 80 degrees of shoulder-girdle movement. The fracture was exposed, the fragments freshened and a nail driven through the great tuberosity across the fracture site

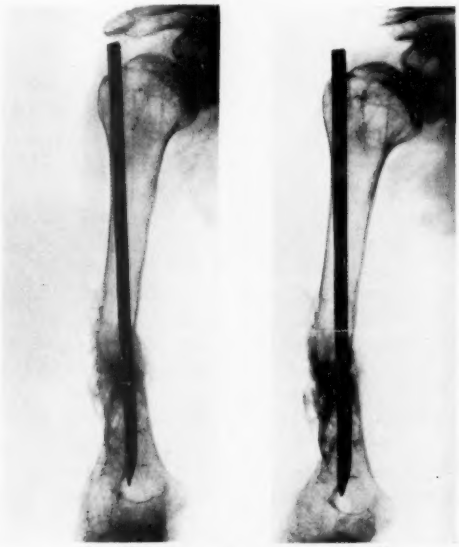


FIG. 27 FIG. 28

Figure 27—Extrusion of nail from upper end of humerus seven weeks after nailing for old ununited fracture. The top of the nail impinged against the acromion process when abduction was attempted. Symptoms were relieved temporarily after excision of the acromion (Fig. 28) but the nail continued to extrude.

of the supracondylar level. Iliac bone chips were packed tightly between the bone ends and the limb was immobilised in a plaster spica for four months. Exercises were then begun but there was increasing discomfort in the shoulder. After seven weeks the end of the nail could be felt under the deltoid, with a fair-sized bursa in which it creaked. There was obvious impingement against the acromion process when abduction was attempted (Fig. 27). Union was not yet consolidated soundly enough to permit removal of the nail, particularly in view of the previous history of many grafting operations which had failed after apparent initial success. It was decided to excise the acromion (Fig. 28); this allowed continued mobilisation of the shoulder, but the nail continued to extrude very slowly and fifteen months after the original operation it was decided to remove it. By this time the end of the nail was lying almost subcutaneously and we expected the extraction to be completed within two minutes. In fact after twenty or thirty minutes of laborious effort I nearly fell backwards across the theatre as it was finally dislodged!

BENDING OR BREAKING OF THE NAIL

The complication of a nail bending or breaking is largely a technical problem that must be tackled by the manufacturers in consultation with orthopaedic surgeons. There can be no doubt that in many if not most of such cases the fault has been that the metal was too soft (Fig. 29) or that the cross-section was unsuitable. The bending forces acting at the site of fracture in a large bone such as the femur are much greater than is commonly understood. Charnley (1950) has calculated that in a person of average height and weight gravity alone may exert a tension force of 220 lb. at the cortex of the mid-femoral shaft when the limb is unsupported: and because the cross-section of an intramedullary nail is less than that of the femur the forces acting upon the nail are correspondingly more severe. When it is considered that to the force of gravity must be added the many extraneous stresses to which an unsupported limb is subject it is not surprising that from time to time there are reports that a nail has broken or bent.

FIG. 29
Bending from the use of too malleable a nail.

In a personally communicated case of a woman aged sixty-three years whose left femur was nailed for an upper shaft fracture complicating Paget's disease, the nail began to bend two months after the operation; radiographs taken at the thirteenth week showed that the nail had broken about one inch below the level of the fracture, which was not yet united. Union was ultimately secured after a prolonged period of external splintage. In such a case, to extract the distal half of the nail would present such formidable difficulties that it would seldom be attempted.

Bending of a nail with angulation of a fractured shaft of the femur—DAVID TREVOR (London, England). A tailoress aged twenty-three years was admitted to hospital in March 1946 with a closed transverse fracture of the middle of the left femoral shaft with gross displacement, the result of a road accident. The fracture was considered suitable for fixation by means of an intramedullary nail; no difficulties were encountered in its insertion a week later. The fracture site was exposed through a small lateral incision and the guide was passed through a curved incision over the great trochanter and made to enter the medulla of the proximal fragment just to the medial side of the trochanter. When the guide had emerged at the fracture site the fragments were accurately reduced and the guide was driven into the medulla of the distal fragment. A suitable nail was threaded along the guide, which was then removed. Knee movements were encouraged from the beginning, walking was allowed ten days later, and at the end of four weeks the patient was discharged home.

Progress was satisfactory until three months after the accident when the patient fell into an empty bath during an epileptic fit. Examination on readmission revealed 30 degrees' angulation of the left femur (Fig. 30). The bent nail could not be extracted; it was therefore decided to attempt to straighten the nail and correct the deformity by closed manipulation although it was not known whether the nail would straighten or snap. With the operator's bent knee against the convexity of the deformity and counter-pressure applied with each hand at the upper and lower ends of the inner side of the thigh, good correction was obtained (Fig. 31). Because of the possibility of further epileptic fits external splintage by a plaster hip spica was considered advisable, and was continued until bony union was sound—seven months after the injury. The nail was then removed (Fig. 32). One year after the injury full function of the limb had been regained.

FIG. 30

FIG. 31

FIG. 32

Figure 30—Angulation of nail and fracture caused by a fall during an epileptic fit three months after nailing. Figure 31—After straightening limb and nail by manipulation. Figure 32 shows union consolidated seven months after nailing.

Further instances of bending of the nail are reported by Palmer and by vom Saal. In Palmer's series of forty-six fractures of the femur treated by nailing, there was bending in five; and he noted several cases of bending with angulation of the fracture after nailing of the radius and the ulna. Vom Saal emphasizes the importance of securing a snug fit of the nail in the bone; he has observed that when a nail fits loosely the risk of bending or breaking is appreciably increased.

JOINT INJURY AND JOINT STIFFNESS

Although the importance of driving the nail through a sufficient length of bone to secure rigid fixation is generally recognised, the accident of overdriving a nail through the articular cartilage into the adjacent joint cavity does not appear to be a serious hazard. In the selection of a nail of appropriate length the margin of safety is fairly wide; and with the additional safeguard afforded by control-radiographs, overdrive into the joint is easily avoided. When joint injury has occurred it was usually caused by a nail that penetrated the soft tissues and encroached upon the joint from *outside* the bone. Harm may be done without penetration: the point of a nail lying close to a joint may interfere with its function by setting up a local irritative reaction or by forming a mechanical block to joint movement.

Penetration of the knee joint by a nail which perforated the anterior femoral cortex —O. J. VAUGHAN-JACKSON (London, England). A man aged twenty-three years had fractured the mid-shaft of the right femur while serving in the Army. Three months after the injury an anterior onlay bone graft had been applied and secured with six screws. Within a few weeks of the operation the graft had broken. The limb was immobilised in a plaster spica. Five months later he was allowed up with a walking caliper, and was finally discharged

from the Army. He first attended the London Hospital sixteen months after the injury; there was gross forward bowing at the site of fracture and the limb was short by one inch. There was mobility at the site of fracture, which was painful. The patient was walking with the aid of two sticks. Radiographs showed an ununited fracture with forward angulation (Fig. 33). It was decided to explore the fracture, remove the screws, freshen the bone ends, immobilise the fracture with an intramedullary nail and pack cancellous bone chips around the site of fracture.

Some initial difficulty was met in removing the screws which were bent within the bone. The fracture ends were freshened and a small wedge of bone with the base anteriorly was removed to permit correction of the angulation and adequate apposition of the fracture ends. A small incision was made over the greater trochanter and a twelve-inch nail was passed down through the upper fragment to the site of fracture. The point of the nail was guided by eye into the lower fragment and the nail driven home. It was considered safe to do this

FIG. 33

FIG. 34

FIG. 35

Ununited fracture of femur fourteen months after bone graft (Fig. 33). Open reduction and fixation with an intramedullary nail were performed, but subsequent radiographs showed that the point of the nail had penetrated the anterior cortex of the femur and was lying close to the upper pole of the patella (Fig 34). At a second operation the nail was withdrawn till its point was flush with the cortex of the distal fragment (Fig. 35).

as the length of the nail was chosen after the length of femur had been measured, and there seemed to be no risk of its point penetrating the distal end of the femur; moreover, the two fragments could be seen to be in accurate alignment. The wound was closed and only on the day after operation was a further radiograph taken to check the position of the nail. It showed that the end of the nail had emerged obliquely through the thin anterior cortex of the lower end of the femur (Fig. 34). The nail clearly had gone on to penetrate the suprapatellar pouch and come to rest against the upper pole of the patella. A further operation was undertaken. The trochanteric incision was reopened and the nail was withdrawn one inch (Fig. 35).

Comment—Though this was a comparatively minor mishap, it draws attention to the fact that, while the thick cortex of the upper two-thirds of the shaft of the femur can be relied on to retain the advancing point of the nail within the medullary cavity, the thin cortex of the lower end is not dependable. However perfect reduction may seem there must always

be—owing to the normal anterior curve of the femoral shaft—a risk of penetrating the anterior cortex of the distal fragment with the nail, which necessarily advances in the axis of the proximal fragment and at an angle to the axis of the lower fragment. No matter how confident the surgeon may feel, it is nevertheless essential to check the position of the nail by radiographs in two planes before closing the wound.

Mechanical interference with movement at the elbow joint by a nail introduced into the humerus from its distal end—J. G. Bonnin (London, England). A middle-aged woman had sustained a fracture involving the lower and middle thirds of the left humerus with separation of a " butterfly " fragment. There was associated paralysis of the radial nerve. Two months after the injury an intramedullary nail had been inserted from the lower end of the humerus and the distal fragment had been wired to it with two encircling loops. After the operation the limb was immobilised on an abduction splint. When she was first seen by the writer two months after the operation there was gross restriction of movement

Fig. 36

Fig. 37

Figure 36—Interference with function of the elbow joint by a nail. Although the nail was left in position for five months a pseudarthrosis developed (Fig. 37).

at the elbow joint, which was practically fixed at a right angle; the shoulder joint was markedly stiff also. There was no evidence of recovery of the radial nerve lesion. Radiographs showed that the fracture was not united. The lower end of the nail was very close to the elbow joint and appeared to form a mechanical block to extension (Fig. 36). A period of intensive rehabilitation was successful in restoring a useful range of shoulder movement, and during this time the nerve lesion recovered fully. The intramedullary nail was removed five months after its insertion and intensive efforts were made to mobilise the elbow. A range of 45 degrees was all that could be achieved and it soon became obvious that union at the fracture site was unsatisfactory. With continued use of the elbow a pseudarthrosis gradually developed, until it became clear that further operative treatment was necessary (Fig. 37). Accordingly the humerus was exposed through an antero-lateral incision, the fracture surfaces were trimmed and freshened into a step-cut formation and a plate was applied. Post-operative progress has been satisfactory to date.

NON-UNION FROM UNPROTECTED WEIGHT-BEARING

The experience of many surgeons has shown that in suitable cases intramedullary nailing can usually be relied upon to secure sound bone-union provided a careful technique is used and a rigid mechanical fixation is achieved. In most examples of delayed union or non-union that have come to our notice the failure has been attributable to the use of the method in unsuitable cases or to errors of technique. If the nail fits too loosely or is too short, fixation will be inadequate and rapid union cannot be expected unless immobilisation is aided by external splintage. An error that is less obvious, though perhaps no less important, is to permit distraction of the fragments during introduction of the nail. An example of this complication is recorded by Palmer in his contribution to this symposium.

Non-union: absorption round nail from early unprotected weight-bearing—REGINALD WATSON-JONES (London, England). A man aged forty-five years sustained a

FIG. 38

Non-union of a fractured femur fourteen months after medullary nailing. Despite a precarious grip of the nail in the distal fragment unprotected weight-bearing had been permitted from the beginning.

fracture of the shaft of the right femur in Switzerland in January 1947. Three days after the injury an intramedullary nail was introduced. Early weight-bearing was permitted. Two months later there was movement at the fracture site. A short thigh plaster was applied and he continued to take weight on the limb. When first seen by the writer fourteen months after the nailing operation the fracture was still mobile. Radiographs showed established non-union and there was evidence of absorption of medullary bone around the distal part of the nail (Fig. 38). Because of the absorptive changes further medullary fixation was considered impracticable. Onlay bone grafting gave sound bone-union within four months.

Comment—The fracture was well below the mid-shaft of the femur and the radiographs suggest that the distal part of the nail was gripped only by cancellous bone. Mechanical fixation was not sufficiently rigid to withstand the stresses of unprotected weight-bearing. If immobilisation

had been aided by external splintage in the early months it is probable that there would have been primary union.

Fragile bones in Paget's disease: multiple fractures after intramedullary nailing of a fractured femur —H. JACKSON BURROWS (London, England). A woman aged sixty-eight, with Paget's disease, broke her right thigh at the junction of lowest and middle thirds, without violence, as she stepped from the Channel packet to enjoy a Continental holiday. From this beginning she sustained three more fractures in the course of treatment during the next five months. The original fracture of the right femur was treated with an intramedullary nail (Fig. 39); two months later, when she was getting out of bed, she broke the left femur; during an operation for nailing this (Fig. 40), the right patella became broken; two weeks before repatriation a "crack" occurred near the lower end of the right femur. It was all the fault of the patient: her "bones were like glass!"

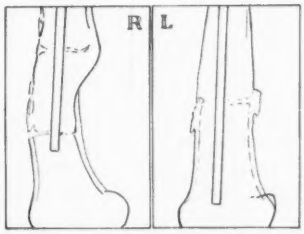


FIG. 39 FIG. 40

Tracings from radiographs. Figure 39—Right femur. The lower fracture occurred four months after nailing the upper fracture. Fracture of the right patella (not shown) occurred during nailing of the left femur (Fig. 40).

REVIEW OF THE COMPLICATIONS IN INTRAMEDULLARY NAILING

FREDERICK VOM SAAL, NEW YORK, N.Y.

The widespread use of any new surgical method is always accompanied by more complications than any one surgeon could imagine possible. The same will be true of intramedullary nailing. No attempt will be made to cover the many possible complications but a few of the major pitfalls will be reviewed. Complications fall into two major groups: those caused by the carelessness of the patient and those caused by the carelessness of the surgeon. The latter group is much the larger and more important.

A properly done intramedullary nailing gives the patient such a complete sense of security that he may become careless. A young man standing at the front of a tram three weeks after nailing was thrown across a seat when the tram started abruptly. The femur was bent at the fracture site (Fig. 41). One of the advantages of intramedullary fixation is that most of one's difficulties can be resolved, and in this case the patient was anaesthetised and the nail straightened manually, using the post of the fracture table as a fulcrum. While the limb was steadied by an assistant, the upper incision was opened, the nail extracted and a new nail inserted (Fig 42). The patient merely suffered the inconvenience of two days' stay in hospital and went back to his former routine. Union continued uneventfully. After such a complication one must not, however, make the mistake of straightening the nail and leaving it, because bending will probably recur.

Since six or seven nails are sterilized for each intramedullary fixation, it is possible for a nail to be repeatedly boiled and discarded until it softens, and then will bend quite easily after insertion. Since this has twice happened to the author it is now his practice not to boil the nails but to place them in antiseptic solution for several hours.

The malleable clover-leaf nail is preferred to the more rigid Hansen–Street pattern because it will adapt itself better to irregularities of the cortex, will not rotate during insertion and as it is less liable to shatter the bone can therefore be inserted snugly. It will bend to follow the normal anterior curve of the femur, and will even follow the marked curve seen so frequently in Paget's disease. This malleability has certain disadvantages as was pointed out above in the case of a nailed femur—and the same holds true for the forearm. The malleable square clavicle nail is much easier to insert, particularly into the radius, but may

occasionally lead to trouble. Figure 43 shows the forearm of a thirty-two-year-old man. Notice in the post-operative radiograph (Fig. 44) how the nail, inserted from the distal end of the radius, has bent and slid down the canal. Five days after nailing the patient disappeared. He went back to truck-driving, taking care of his three children and even doing the family wash. He returned after six weeks with a bent forearm (Fig. 45), union, excellent function but permanent limitation of supination of 45 degrees. In uncertain cases, and to guard against a euphoric patient, it is better to use the more rigid V-nail in the ulna and to use double malleable nails only in patients who can be supervised.

After nailing of both bones of the forearm a difficult problem may arise when one bone unites more rapidly than the other. In fractures of the proximal part of the forearm particularly, the radius tends to unite first and then distracts the ulna. Figure 46 shows a united radius holding apart the ulnar fragments with resultant non-union. It is advisable in this type of injury to lay bone grafts across the ulnar fragments, even in fresh fractures.

FIG. 41 FIG. 42

Figure 41—Bent nail. Figure 42—After removal and insertion of new nail.

Because of its configuration the humerus is the least satisfactory bone in the body for intramedullary nailing. For shaft fractures the nested V-nail should be used. One is sometimes tempted to use a single nail because fixation seems adequate but consideration of the following two cases should serve as a reminder of the risk incurred. The first (Fig. 47) shows a transverse fracture of the mid-humerus which was exposed because of a radial nerve paralysis; nailing was done from below. Fixation seemed adequate, but the nail gradually slid distally out of the bone (Fig. 48)—presumably because of the forces of gravity and of movements of the arm. The fracture angulated a little but fortunately united. Some difficulty was experienced because the nail gradually worked its way out through the skin. If the nail comes out before union, all fixation is lost. This happened in the second case. The fracture was nailed from above in an attempt to overcome the gravity factor. Nevertheless the nail began to migrate down through the bone and some absorption took place around it. Fixation was therefore lost and non-union became established. The difficulty was overcome by the use of nested V-nails, the ends of the two nails being bent apart so that it was impossible for them to migrate or for the fragments to rotate. This method ensures adequate fixation in a fresh fracture. In non-union—because there is a distraction rather than an impaction factor in the humerus—the fracture may still fail to unite unless bone grafts are applied to the humerus. Full use can then be allowed and rapid union is the rule.

Carelessness in the selection of nails can easily bring disaster. When the nail is too short or too narrow rotation, bending or breaking happens easily. It is also possible to select a nail that is too large. This happened in one of our cases of femoral shortening (Fig. 49). The nail became impacted in the canal and, when it was hammered, simply drove the fragments apart at the site of osteotomy. So much force was used in trying to extract the nail that the end was broken off. The nail was finally pulled up and the fragments so brought back into

apposition; the end of the nail was then sawn off with a hacksaw. Fixation was adequate because the nail was tightly stuck in the canal, a much better condition than when a nail is too loose. In spite of the operative difficulty the patient did very well. Within fourteen days there was a large amount of callus around the osteotomy site. After seven months, when union was secure, the nail was removed without difficulty.

Inserting a nail that is too loose or too short is easier for the surgeon but a real danger to the patient. In a mid-femoral fracture the leverage on a loose nail may equal several thousand pounds. As a result the nail may easily bend or break (Fig. 50). If the nail is snug the force is markedly reduced. A loose or short nail may also allow rotation of the fragments. One must also remember that *all* intramedullary nails loosen. If the patient is kept off the

FIG. 43 FIG. 44 FIG. 45

Figure 43—Radiograph before operation. Figure 44—Malleable nail in radius has followed the shape of the canal. Figure 45 shows angulation of the nail and the fracture.

FIG. 46

Radius has united first and the ununited ulnar fragments are being held apart.

foot, atrophy and absorption are hastened and the nail will loosen more rapidly; then, when weight-bearing is finally allowed, one has the same problem as in a poor loose insertion. Inferior metals may also break or bend. The nails should be made of 18/8 S.Mo steel and carefully tempered so that they are neither brittle nor too soft. A reliable manufacturer is important.

In one case of femoral shortening we encountered a complication peculiar to intramedullary nailing. The piece of bone removed for the shortening was cut up and part of it laid about the osteotomy site, but the grafts were not fastened. The patient was allowed out of bed in twenty-four hours with weight-bearing. Radiographs taken three days later showed that the early movement of the soft tissues around the osteotomy site had scattered the bone

FIG. 47

FIG. 48

Extrusion of nail after intramedullary fixation of a fracture of the humerus.

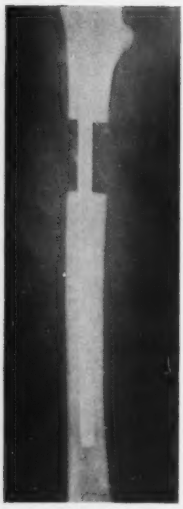


FIG. 49

Distraction of the fragments caused by hammering a nail which was impacted in the distal fragment.

FIG. 50

Breakage of a nail that was too narrow. (Radiograph from a case of Dr Arthur Thibodeau.)

FIG. 51

Scattering of applied bone grafts due to early movement of the soft tissues surrounding the site of osteotomy.

grafts (Fig. 51). Although this did not slow down healing it did cause an undesirably large mass of callus. So it is better when using supplementary bone grafts after intramedullary nailing to fasten them to the shaft by means of circular chromic catgut, silk or wire. This was done in another case of femoral shortening, two grafts being fastened on with chromic catgut. Radiographs seven months later showed secure union. The patient had begun walking after twenty-four hours; at one month he was swimming and enjoying all sorts of exercise short of competitive sports. However, the case illustrates another point. The upper end of the femoral nail protruded a fair distance from the femur. This also is undesirable. There are two complications. First, the nail tends to hook under the glutei when the patient sits; and when he sits on a low chair he may not be able to get up. Second, the oscillation of the end of the nail causes the formation of a bursa: which may become calcified. After removal of the nail there were no symptoms from the calcification. The nail should not protrude more than one inch from the trochanter.

To sum up: there are many possible complications of intramedullary nailing, most of them springing from carelessness or lack of understanding of the principles of intramedullary fixation.

Conclusions—The fracture should be treated by open reduction. The nail selected must fit the canal snugly and be buried in cancellous bone at each end of the shaft. In the tibia and humerus, multiple nested V-nails should be used to prevent migration and rotation. Movement and impaction should be begun immediately with the upper extremity, and weight-bearing with the lower extremity. Each of the above points is a " must "; if they are rigidly observed, complications will be at a minimum and the surgeon will have at his command a method which provides the most rapid union with the least cost and the greatest return of function.

REVIEW OF THE COMPLICATIONS AND TECHNICAL PROBLEMS OF INTRAMEDULLARY NAILING

IVAR PALMER, STOCKHOLM, SWEDEN

The purpose of this paper is to summarize my experiences of the difficulties of intramedullary nailing. I do this with some hesitancy, for it is not pleasant to speak only of the faults of a dear friend. However, intramedullary nailing has proved itself to have so many true virtues that we can afford to discuss its negative qualities too. Few methods have given us so many happy surprises. The after-treatment of patients has been simplified, the stay in hospital has been shortened and, as our experience accumulates and our technique improves, so complications have grown increasingly rare. Success in intramedullary nailing depends to a great extent on the skill and experience of the surgeon. The operation should not be attempted by surgeons unaccustomed to bone and joint surgery or who have a limited fracture material at their disposition.

Many of the difficulties of the operation have been appreciated and remedied. But there is still room for improvement. Technical equipment has certainly not yet reached perfection. Among early errors I am inclined to include the original theory that fractures should be reduced by the closed method, either manually or with the aid of various types of reducing apparatus. The closed method does not always give sufficiently exact reduction to permit precise nailing; consequently the nail may escape into the surrounding soft tissues; renailing is often necessary; the operation may take an unexpectedly long time, and may entail numerous radiographic exposures, bringing the danger of X-ray burns to both patient and attendants. In the author's opinion it is as a general rule unwise to attempt closed reduction.

Every case of intramedullary nailing undertaken in my service during the period 1944 to 1950 has been reviewed. Nailing was performed for the following fractures:

Femur	46 cases
Tibia	10
Upper end of the humerus	25
Shaft of the humerus	32
Ulna with dislocation of the head of the radius (Monteggia)	10
Radius with subluxation of the lower end of the ulna	8
Radius and ulna (antebrachial fracture)	27
Metacarpus	3
Clavicle	3
Total	164 cases

The complications and technical problems that have developed in the treatment of these cases are not necessarily disclosed by the case reports, some surgeons undoubtedly preferring not to mention their difficulties. In the following paragraphs I shall therefore confine myself to the more striking complications from which lessons have been learnt. Errors and complications of the method may be placed in the following categories: 1) Technical errors that are manifested during the course of the operation. 2) Post-operative complications arising from some technical error during the operation or unsuitable post-operative treatment. 3) Post-operative complications not arising from technical errors or unsuitable post-operative treatment. Since the anatomical conditions—and consequently the technical problems—vary in the different groups of fracture, each type must be studied separately.

Fractures of the Femur

Forty-six patients were operated upon, one for open fracture. In the post-operative treatment no external fixation was used at all in some cases, walking on crutches being permitted after one week. In other cases fixation in the " snow-plough " splint was used—that is, a simple wooden splint supporting the limb in slight abduction and neutral rotation for two to six weeks. Fractures of the femur, like those of the ulna, are especially suitable for intramedullary fixation. A straight nail can be inserted from the apex of the bone (greater trochanter, olecranon) which is easily accessible.

Operative difficulties. *Indications*—The first problem is to decide whether the particular fracture is suitable for intramedullary nailing. The most suitable are transverse fractures of the shaft, unless they are moderately oblique or comminuted with small fragments, in which event the method is contra-indicated. The subtrochanteric abduction fracture is also well suited for intramedullary nailing, unless the trochanteric fragment is splintered. Supracondylar fractures may also be nailed provided the fracture line is almost transverse. Any fracture that is grossly comminuted is unsuitable for nailing; fixation is poor and union may be delayed because of defective vascularity of the intermediate fragments. If there is a large intermediate fragment, nailing and circumferential wiring may be combined to advantage. But under no circumstances should the intermediate fragment be dissected away from its soft-tissue attachments.

Impaction—The next difficulty is to choose a nail of the correct size. Radiographs give an estimate of the calibre of the medullary canal, but mistakes are easily made. Very often the nail has met resistance when being inserted; it has had to be extracted, occasionally with considerable difficulty, and replaced by a smaller nail. The opposite situation has also been encountered: the nail enters too easily, in which case it has to be extracted and replaced with a larger one.

In one case the nail became impacted before it reached the distal fragment and had to be sawn off and left where it was, the fracture then being treated with traction. In another, the shaft of the femur was split during a stubborn attempt to force in too coarse a nail; fortunately this did not interfere with the healing process. *Rule*—Force must never be used. The nail should be extracted and discarded if difficulty is encountered on insertion.

Finding the passage—Some experience is required to be able to locate the medullary canal when driving the nail in. The simplest way is to begin from the tip of the trochanter (Fig. 52)—not from the trochanteric fossa—and to determine the direction by localizing the distal end of the proximal fragment. A hole four to five centimetres long should be made in the correct direction with a strong pin-driver. The ring of the metal when the nail penetrates through the medullary canal will serve as guidance for the experienced operator. In at least three cases the surgeon unwittingly drove the nail through the neck into the medial soft parts (Fig. 53); fortunately no harm was done. *Rule*—The nail should be introduced from the tip of the trochanter and great care should be taken to determine the correct direction before driving the nail.

The nail passes alongside or penetrates the distal fragment—The nail is driven down through the proximal fragment until it is judged to have reached the level of the fracture. If it is inserted too far its withdrawal may be difficult (Fig. 54). The fracture is then exposed and is exactly reduced. The nail is driven in farther, but this time by an assistant while the surgeon sees to it that the reduction is maintained as the nail continues its progress. The nail has an amazing faculty for making its way out to the side of the distal fragment. The greatest care must be taken to reduce the fracture in exact alignment. If any angulation is allowed the position will be locked by the nail when it is inserted and the nail may force its way out and possibly penetrate the knee joint at the epiphysial line (Fig. 55). This has occurred in one case. *Rule*—The nail must be inserted only to the level of the fracture before the exploration. Apposition and alignment of the fragments must be exact.

Post-operative complications caused by technical errors. *Distraction of the fragments; delayed union*—In one case of transverse fracture, distraction of about half a centimetre developed during nailing. The post-operative course was characterised by delayed union and a tendency to pseudarthrosis. At a second operation the distraction was reduced and the nail reinserted. The fracture united. *Rule*—Avoid distraction of the fragments.

Bending of the nail—In five cases the nail bent post-operatively as a result of weight-bearing or muscular action or, in two cases, from accidental injury. If a nail bends there is little point in trying to straighten it. Its strength will be reduced, it will bend again and ultimately break. The very suggestion of a bend in the nail should cause the surgeon to change nails. This is both quick and easy. The bend is straightened gently by correcting the deformity in the extremity, the nail is extracted and a new and somewhat shorter nail is immediately inserted. The second nail should be larger, because the first one will have become loose in the canal.

If healing is delayed, which often happens in transverse fractures no matter how they are treated, it can be stimulated by exploring the fracture and packing the area around it with cancellous bone chips. *Rule*—If a nail bends it should be discarded immediately. Explore, and insert cancellous chip grafts if union is delayed.

One case of the five mentioned above caused trouble. The patient was a very obese fourteen-year-old girl. The nail had been badly bent in an accident. Extraction proved impossible because at the first operation the nail had been sawn off below the extraction hole; further, the obesity of the patient made it impracticable to drill a new hole. Ultimately the surgeon managed to straighten the nail and to withdraw it a short distance so that a sound section was brought to the level of the fracture. *Rule*—Never use improvised, unsuitable material. Make sure that the nail is the right length before driving it in. See to it that the nail always is provided with an extraction hole.

FIG. 52

FIG. 53

The nail should be introduced at the tip of the greater trochanter (Fig. 52). If it is introduced in the trochanteric fossa the nail may penetrate the medial cortex of the femoral neck (Fig. 53).

FIG. 54

Nail has been driven too far before exploration of the fracture. It has missed the distal fragment and penetrated the soft tissues.

FIG. 55

Angulation has not been adequately corrected. Nail has penetrated anterior cortex and entered the suprapatellar pouch.

FIG. 56

Calcified bursa around the upper end of the nail.

Post-operative complications independent of technical errors. *Fat embolism*—It is difficult to decide whether fat embolism is more common with intramedullary nailing than with other methods. Lauritzen (1948) reported two cases of fatal fat embolism in a series of thirty-eight cases. My material includes two cases of pulmonary fat embolism, neither of which was fatal.

Thrombosis was seen in one case.

Bursitis at the upper end of the nail—Enough of the nail should be left free above the tip of the trochanter to enable it to be extracted. However, the end of the nail may irritate the tissues and give rise to a sometimes painful bursa formation. Occasionally the wall of the bursa will become calcified, in which case it can be seen clearly in the radiographs (Fig. 56). No case of infection was observed.

Fractures of the Tibia

Ten patients were nailed—two for open fractures. After operation, the patients walked immediately in an ordinary long leg plaster. Because of its shape the tibia is not well suited for intramedullary nailing: the profile of the medullary canal is like an hour-glass, which means that the nail easily becomes impacted in the narrow, middle part of the bone. The method is not advisable in these fractures.

FIG. 57
Nail is impacted in the medullary canal. It provides only slight fixation of the distal fragment.

Operative difficulties. *Indications*—We have confined the use of the method to transverse fractures in the middle and lower parts of the bone. Other types of fracture are better treated by alternative methods.

Impaction—The most suitable width of nail is more difficult to determine for the tibia than for the femur. For the tibia it should be as coarse as possible, otherwise fixation will be poor; but it must be narrow enough to pass through the constricted central part of the bone.

The nail became impacted in two cases. In one of them it had penetrated one centimetre into the distal fragment before it became impacted, and it therefore did some good (Fig. 57). In the other case it never reached the lower fragment. It had to be sawn off and left in place, after which the fracture was fixed by wiring. A few weeks later the nail was removed without difficulty as its track had become widened by decalcification.

Wrong approach—If an intramedullary nail is to be inserted from the side into the tibial shaft a very oblique entrance canal must be prepared and the tip of the nail must be slightly curved. In one case in which these two rules were not observed the nail showed a stubborn tendency to perforate the cortex at the level of the fracture where the resistance of the wall was decreased (Figs. 59 and 60).

FIG. 58
Nailing with distraction which resulted in delayed union.

Post-operative complications caused by technical errors. *Distraction; delayed union*—In one case the nailing caused considerable distraction (Fig. 58) and greatly delayed union; nevertheless the fracture was consolidated after fourteen months. This patient was one submitted to intramedullary nailing for open fracture of the tibia.

Bending of the nail—In three cases the nail bent post-operatively and permitted angulation of the fracture which could only be partly

corrected. The complication develops from the nail being driven in from the side with some curvature. The risk of deformation is increased if the entrance canal is not made sufficiently oblique.

Complications independent of technical errors—There were no cases of fat embolism, thrombosis or infection.

Fractures of the Upper End of the Humerus

Twenty-five patients were treated. After nailing, the arm was supported in slight elevation with neutral rotation and the hand suspended for the first week. Thereafter a sling was applied with a cushion for support. Exercises were begun on the first day.

Intramedullary nailing is very useful in displaced fractures of the neck of the humerus. The nail is introduced through an oblique canal beneath the deltoid tuberosity where the shaft is directly beneath the skin. When it has reached the level of the fracture, the fracture is exposed through a deltoid-splitting incision. The long tendon of the biceps serves as a guide to avoid a rotatory displacement between the fragments during reduction. The nail is driven up through the head but penetration is avoided. The fracture immediately becomes stable.

FIG. 59

FIG. 60

Figure 59—The nail, the tip of which is not sufficiently curved, has been introduced incorrectly. It has penetrated the soft tissues at the level of the fracture. Figure 60—The mistakes have been corrected and the final result is satisfactory.

FIG. 61

Myositis ossificans after splintering of the upper end of the humerus by a nail driven in from below. The nail was withdrawn and reintroduced from above.

Operative difficulties. *Penetration*—In one case the nail penetrated the head, but had to be left where it was because of the smallness of the head fragment. It was extracted later. The complication had no ill effect.

Post-operative complications due to technical errors. *Splintering of the bone: Myositis ossificans*—In one case in which the nail used was too wide, the upper part of the shaft was splintered when the nail was driven in. The old nail was extracted and a new one inserted in the opposite direction—that is, from the greater tuberosity downward. After the operation, however, myositis ossificans developed at the site of penetration of the nail (Fig. 61). Post-operative mobility in the shoulder joint was poor.

Wrong approach; radial palsy—In one case in which the nail penetrated the medial wall of the distal fragment, the patient had temporary radial palsy after the operation. The nail had obviously been in contact with the nerve cord.

Fractures of the Shaft of the Humerus

Thirty-two patients were operated upon. Three had open fractures. Post-operative treatment was the same as for fractures of the upper end of the humerus. The fracture may be fixed either from above with a straight nail driven in through the greater tuberosity, or from below through an oblique canal in the mid-line of the dorsal aspect of the humerus. We have used the latter method in order to avoid damaging the subacromial bursa of the shoulder joint.

Operative difficulties. *Wrong approach; radial palsy*—In one case the nail took the wrong direction and made its way out into the soft parts at the level of the fracture. It apparently caused superficial damage to the radial nerve, for the patient had a brief attack of radial palsy after the operation.

Distraction—In one case distraction of the fragments was caused by the insertion of the nail. A transverse fracture of the humerus heals slowly and every effort must be made to create favourable conditions for consolidation. Re-nailing was successful.

Post-operative complications. *Infection*—A mild infection developed in one case but healed after removal of the nail. No case of pseudarthrosis was observed.

Fractures of the Upper Half of the Ulna with Dislocation of the Head of the Radius (Monteggia Fracture)

Ten patients were treated. One fracture was open and one had been neglected and had established non-union. Post-operative treatment was in a forearm plaster and sling.

It is a simple matter to drive a nail through the tip of the olecranon, reduce the fracture and achieve excellent fixation. At the same time the head of the radius also slips into position. Care should be taken, however, to avoid distraction of the fragments. If distraction does occur and cannot be corrected, the gap can be filled in with bone chips. There were no difficulties or complications connected with operation. All the cases united with good function in the elbow joint. In the patient with established non-union the radial head was later excised.

Fractures of the Shaft of the Radius with Subluxation of the Inferior End of the Ulna

Eight cases were treated, one for open fracture. Post-operative treatment was as described above. Nailing of fractures of the radius was done from the inferior dorsal part of the bone immediately above the wrist. The subluxation of the lower tip of the ulna was relieved automatically when the radial fracture was restored to its correct position.

Operative difficulties. *Impaction*—In one case in which a narrow Kirschner wire was introduced as a guide and an intramedullary nail then inserted beside it, both guide and nail became stuck and had to be left where they were. The guide gave a certain degree of fixation in the fracture. The nail and guide were removed six weeks later. No ill effects were noted.

Post-operative complications. *Shortening and radio-ulnar subluxation*—In one case the radius united with shortening of the bone, and the subluxation of the lower end of the ulna reappeared. The lower end of the ulna was excised after consolidation of the fracture. The end-result was satisfactory.

Fracture of the Radius and Ulna with Gross Displacement

Twenty-eight cases were treated; five had compound fractures. The post-operative treatment was as described above. The material included eight cases of intramedullary

nailing of both radius and ulna, seven of nailing of the ulna alone and thirteen of the radius alone. In two cases intramedullary nailing was combined with wiring of the other bone.

The displaced double fracture of the forearm is a very difficult injury to treat, regardless of the method used. Intramedullary nailing presents many problems and with it we have encountered greater technical difficulties than with any other method. Difficulty is caused mainly by the small diameter of the medullary canal in the middle third of the shafts of the radius and ulna. Dr Kock, one of my assistants, has recently evolved a method which we call " retrograde medullary nailing." A relatively short nail is inserted first backward through the fracture surface in one fragment and then back again down through the other fragment to half its length. In this way the canal for the nail can be prepared in advance if the medullary space is narrow. The method is to be described by Dr Kock in a later communication.

FIG. 62

A wire of ordinary steel was used for the radius, and a stainless steel nail for the ulna. The radius shows large areas of local bone resorption.

Operative difficulties. *Impaction*—It has been impossible to determine from the case records exactly how often the surgeon encountered difficulty from the impaction or bending of nails. It was always possible, when necessary, to remove the nail and replace it with a new one during the course of the operation.

Distraction—In one case the first nailing was unsatisfactory and caused distraction of the fragments. Re-nailing was done.

Post-operative complications. *Poor material*—In three cases, because the medullary canal was very narrow, the fragments were fixed with a Kirschner wire of ordinary steel instead of with a nail. Post-operatively, local areas of bone absorption or decalcification, attributed to rust granuloma, were associated with some generalised osteoporosis (Fig. 62).

Rule—Never use anything but dependable stainless material.

Bending of the nail—In several cases the radial nail bent quite considerably after the operation. Union occurred in a position of angulation which led to a disabling block to pronation.

Pseudarthrosis—Pseudarthrosis developed in one of the bones in five cases, once in the ulna after double nailing, twice in the ulna after ulnar nailing and twice in the radius after radial nailing.

The series is too small to permit definite conclusions, but it indicates that with the present technique the method is attended by too great technical drawbacks. We hope for better results with the " retrograde " method and a modified technique.

The Metacarpus

Retrograde nailing was successfully performed in three cases of displaced fracture of the metacarpus.

The Clavicle

Retrograde nailing was performed in three cases of greatly displaced fractures in which retention had been difficult. Union was rapid and the results satisfactory.

The entire series of 164 cases includes one case of death from encephalomalacia. This patient was a sickly sixty-six-year-old woman with a subtrochanteric fracture of the femur. The death cannot be attributed to the method.

Investigation of a very large series would be required to answer the question whether union is expedited by this method. The impression gained from the material studied was that the healing period was about neither shorter nor longer than is ordinary.

The stay in hospital, on the other hand, is appreciably shortened. This, together with the comfort and freedom of the post-operative treatment from the point of view of the patient, is undoubtedly the greatest advantage of the method.

Summary

One hundred and sixty-four cases of intramedullary nailing of the long bones have been studied with special reference to the difficulties and complications encountered.

There was one death not attributable to the method.

Two cases of pulmonal fat embolism and one case of thrombosis occurred, all in fractures of the femur.

The lessons we have learned from our mistakes can be summarised as follows:

1. The method requires technical experience and knowledge and is not suited to inexperienced surgeons or surgeons with little fracture material at their disposal.
2. Intramedullary nailing should only be used in fractures to which the method is suited. In general, comminuted fractures or fractures near a joint are unsuitable.
3. Open reduction is preferable to closed methods.
4. The nail should never be driven in with violence. It should be removed and replaced with a new one if difficulty is encountered when inserting it.
5. In fractures of the femur the nail should be driven in from the tip of the trochanter after careful determination of the direction.
6. The nail should be introduced only to the level of the fracture before exploring and reducing the fracture.
7. Distraction of the fragments must be avoided.
8. If the nail bends it should be replaced by a new one, at least in femoral fractures.
9. If union is delayed, the fracture should be explored and chip grafts of cancellous bone placed around it.
10. Improvised nails or nails which are not made of absolutely reliable material should never be used.
11. Make sure that the nail is equipped with an extraction hole for removal.

REFERENCES

BÖHLER, L. (1948): Medullary Nailing of Küntscher. London: Baillière, Tindall & Cox.

CHARNLEY, J. (1950): The Closed Treatment of Common Fractures. Edinburgh: E. & S. Livingstone Ltd.

GROVES, E. W. HEY (1916): On Modern Methods of Treating Fractures. Bristol: John Wright & Sons Ltd.

GROVES, E. W. HEY (1918): Ununited Fractures with Special Reference to Gunshot Injuries and the Use of Bone Grafting. British Journal of Surgery, **6,** 203.

HOGLUND, E. J. (1917): New Intramedullary Bone Transplant. Surgery, Gynecology and Obstetrics, **24,** 243.

LAMBOTTE, A. (1909): Technique et indications de la prothèse perdue dans le traitement des fractures. Presse Médicale, **17,** 321.

LAMBOTTE, A. (1913): Chirurgie Opératoire des Fractures. Paris: Masson et Cie.

LAMBRINUDI, C. (1940): Intramedullary Kirschner Wires in the Treatment of Fractures. Proceedings of the Royal Society of Medicine (Section of Orthopaedics), **33,** 153.

LANE, W. A. (1893): On the Advantage of the Steel Screw in Ununited Fractures. Lancet, **ii,** 1500.

MÉNÉGAUX, G., ODIETTE, D., and MOŸSE, P. (1934): Action cytotoxique de quelques métaux sur le tisue osseux. Presse Médicale, **42,** 1844.

NICOLAYSEN, J. (1897): Nordiskt medicinskt Arkiv, **8,** 1.

RUSH, L. V., and RUSH, H. L. (1939): Technique for Longitudinal Pin Fixation of Certain Fractures of the Ulna and of the Femur. Journal of Bone and Joint Surgery, **21,** 619.

SMITH, H. (1950): Intramedullary Nailing. Journal of Bone and Joint Surgery, **32-A,** 464.

SMITH-PETERSEN, M. N., CAVE, E. F., and VANGORDER, G. W. (1931): Intracapsular Fractures of the Neck of the Femur. Archives of Surgery, **23,** 715.

SOEUR, R. (1946): Intramedullary Pinning of Diaphysial Fractures. Journal of Bone and Joint Surgery, **28,** 309.

STREET, D. M. (1950): Medullary Nailing of the Femur. Journal of the American Medical Association, **143,** 709.

VENABLE, C. S., STUCK, W. G., and BEACH, A. (1937): Effects on Bone of the Presence of Metals: Based upon Electrolysis. Annals of Surgery, **105,** 917.

WATSON-JONES, R. (1943): Fractures and Joint Injuries. Edinburgh: E. & S. Livingstone Ltd. Third edition.

ENDOCRINOLOGY AND ORTHOPAEDICS IN FIFTY YEARS

S. LEONARD SIMPSON, LONDON, ENGLAND

Consultant Endocrinologist, St Mary's Hospital, and Samaritan Hospital for Women; Endocrinologist, Paediatric Unit, St Mary's Hospital

The growth of special branches of medicine has paradoxically upset any claim that they might have had to independence, and has revealed widening zones of overlap. The danger is that such zones may become No-man's-land, and the breadth of view of this Journal has encouraged me to fulfil a request by the Editor to record recent developments of endocrinology in relation to orthopaedics. Those who remember the impact of the discovery of vitamin D on the problem of rickets will not be surprised that advances in endocrinology have already re-orientated the approach to some orthopaedic problems, and that they promise still more from the point of view of etiology, differential diagnosis and therapeutic methods. The more obvious field is that of the parathyroids, but the adrenals, pituitary, thyroid and gonads have a part and each will be considered in their more general aspects.

PARATHYROID GLANDS

Physiology—In 1925 Collip and Hanson, working independently, produced a potent parathyroid extract capable of biological standardisation. A Collip unit is a one-hundredth part of the amount which produces a five-milligram rise in blood-serum calcium in a twenty-kilogram normal dog within fifteen hours. A single large injection of parathormone given by the intramuscular route in normal animals leads to gradual increase of serum-calcium, starting within a few hours, reaching its maximum in sixteen hours, and falling to normal in the next twelve hours. Diuresis begins within a few hours and is associated with increased excretion of chlorides and phosphates. Increased urinary excretion of calcium occurs some hours after the serum-calcium has risen; but the faecal excretion of calcium and phosphorus is not changed appreciably. Tetany may be relieved as soon as thirty minutes after intravenous injection of parathormone and relief is associated with immediate excretion of phosphates and diuresis.

There are two theories of the mechanism by which parathormone acts. The older theory is that calcium is mobilised directly from the bones into the blood stream, with resulting osteoporosis over a period. Selye in 1942 supported this theory by showing that in nephrectomized rats parathormone produced osteoclastic absorption of bone within thirty-two hours of injection. The second—the renal—theory of action postulates that parathormone first produces increased urinary excretion of phosphorus with lowering of the serum-phosphorus, and that mobilisation of calcium from the bones is a secondary change by which an attempt is made to maintain a constant calcium-phosphorus concentration. Certainly in parathyroidectomized animals parathormone first produces phosphate diuresis with lowering of the high serum-phosphate concentration, and then slow increase in the subnormal serum-calcium. The phosphate diuresis starts within an hour; but the rise of serum-calcium may be delayed for twenty-four hours.

Clinical and pathological observations—As is so often the case, clinical and pathological observations preceded experimental and biochemical proof of parathyroid disorder by some years. In 1891, to honour the seventy-first birthday of Rudolf Virchow, the founder of cellular pathology, his pupils published a Festschrift. One of the contributors was Professor von Recklinghausen of Strasbourg who reported the autopsy findings in a series of sixteen patients suffering from a variety of bone diseases. According to Albright (1948) three of the

cases were characteristic of hyperparathyroidism, and the term " osteitis fibrosa cystica of von Recklinghausen " was applied. Case 7 was interesting. In 1888, Herr Bleich fell from a ladder and fractured the neck of his femur; a few months later he slipped and fractured his clavicle; while being nursed he again slipped and fractured the shaft of one femur. In the surgical clinic it was noticed that several long bones were bent and that there had been progressive loss of weight. He died in 1889 in a marasmic condition. Von Recklinghausen did the autopsy and emphasized three of the chief pathological characteristics of bone disease in hyperparathyroidism—widespread fibrosis, cysts and brown giant-cell tumours. Von Recklinghausen did not realise the significance of his laconic observation that " above the left thyroid gland, a lymph gland, red-brown in colour, is present." This was probably a parathyroid adenoma. In 1903 Askanazy described such a parathyroid tumour in a case of osteitis fibrosa cystica. Erdheim was the first to associate the parathyroids with calcium metabolism. Albright describes Professor Jacob Erdheim as an eminent and inquisitive Viennese pathologist whose favourite question was " *Was ist die Ursache ?* " He first observed lack of calcification in the teeth of rats deprived of their parathyroids. He then studied the parathyroids in bone disease, noticed multiple enlarged parathyroids in patients dying of osteomalacia and in rats with rickets, and concluded correctly that parathyroid enlargement was an endeavour to compensate for low blood-calcium. It was not, however, until 1915 that Schlagenhanger, also of the Viennese school, established that a single parathyroid adenoma was a common finding in generalised osteitis fibrosa; he also postulated that this was a primary fault and the cause of the bone disease. The next step was taken by Felix Mandl, a pupil of the famous Professor Anton von Eiselsberg. The patient was Albert, a street car conductor thirty-eight years of age, who for a few years had complained of fatigue and of pain in his leg and hip; radiographs showed that the bones were transparent and cystic. Von Recklinghausen's disease was diagnosed. A white sediment (calcium) was noted in the urine. On July 30, 1925, Mandl explored the neck and removed a parathyroid tumour. Within six days the calcium sediment had disappeared from the urine and within a few weeks the pain in the bones was gone; the crutches were thrown away; and after a few months the rarified bones regained normal density.

During the next few years there was active physiological and biochemical experimentation, culminating in 1930 when the results were applied scientifically to a case of parathyroid tumour by Bauer, Albright and Aub in Boston. The history is of a Captain Martell, who began to have pain in his back, accompanied by round shoulders, loss of height, and fractures of the long bones without sufficient injury. Investigation, first by Du Bois at the Bellevue Hospital in New York and later by Aub at Boston, showed a high serum-calcium and negative calcium balance corresponding to 100 units of parathormone daily. Six explorations of the neck were undertaken for a parathyroid tumour without success until finally Edward D. Churchill split the patient's sternum and found a parathyroid tumour hidden behind it, indicating (as others later confirmed) that it may be necessary to search far from the normal anatomical site if biochemical tests indicate a parathyroid adenoma. Grievously this patient died from post-operative complications.

Sometimes the surgeon may find four hyperplastic parathyroid glands rather than a single adenoma; nevertheless they may still be the cause of generalised osteitis fibrosa. Two or three of the glands must be removed according to their size, care being taken to control post-operative tetany. The condition is comparable to bilateral adrenal-cortex hyperplasia in virilism, and it may be that the pituitary is the initiating gland. Donald Hunter of London, pursuing his early interest in industrial medicine, worked with Aub at Boston on the relationship between lead and calcium metabolism and brought back to England the Boston approach to hyperparathyroidism. Together with masterly histological studies by Professor Turnbull he published in convincing form the story of hyperparathyroidism (1931).

A case of my own, which was observed for several years, displayed classical features. The patient, an unmarried woman aged forty-one years, complained of a lump on the left tibia; the lump was removed and found to be an osteoclastoma. Radiography revealed generalised osteitis fibrosa cystica and multiple minute calculi in the kidneys (as is found with overdosage of parathormone). The serum calcium was raised, 15·6 milligrams per 100 cubic centimetres; the serum-phosphorus was lowered, 2·5 milligrams; and the phosphatase was considerably raised, 61 Bodansky units—all typical findings. There was a negative calcium balance. Mr F. W. M. Pratt explored the neck and removed a large parathyroid adenoma. There followed transient post-operative tetany but subsequently the biochemistry became normal and the bones recalcified. A few years later the patient died in uraemia, the multiple renal calculi having led to progressive fibrosis of both kidneys.

To the orthopaedic surgeon the clinical evidence of hyperparathyroidism may take the form of one or more fractures sustained without sufficient trauma, of bony swelling in the long bones or jaw, of pain in the bones, of rounding of the shoulders with kyphosis and shortening of stature, or of generalised osteoporosis with cyst formation. There may also be weakness, loss of weight, polyuria, renal colic, haematuria, renal calculi or gastro-intestinal disorder. The blood-calcium is raised and the blood-phosphorus is lowered. (But if the kidneys have already been damaged severely the characteristic features may be distorted by failure of the kidneys to excrete phosphorus.)

The experience of the surgical aspects of hyperparathyroidism at the Mayo Clinic was summarised by Black in 1948: "Sixty-three patients with proved hyperparathyroidism were observed at the Mayo Clinic through 1946. The disease was due to a single adenoma in fifty-six cases, to multiple adenomas in three cases, and to diffuse primary hyperplasia in four cases. The ages of the patients ranged from the second to the seventh decades. Complications of the urinary tract were more common and more important than osseous complications.* The treatment of hyperparathyroidism is surgical. Adenomas should be removed completely, and in cases of diffuse primary hyperplasia the hyperplastic tissue should be excised subtotally with the preservation of between 30 and 200 milligrams of hyperplastic tissue. In more than 80 per cent of cases the abnormal tissue may be found by dissection under direct vision through a cervical incision (cervical and posterior superior mediastinal dissection). A second operation, through a sternotomy incision, will be necessary in the remaining cases (anterior superior mediastinal dissection). Secondary dissection is more difficult and far less certain than primary dissection, so that every effort should be made, both in identifying the parathyroid glands present and in designating those missing, at the first cervical dissection."

Post-operative tetany—Some 50 per cent or more of patients who have had removal of a parathyroid adenoma, or subtotal removal of hyperplastic glands, develop symptoms of tetany of variable intensity, associated with an acute fall of serum-calcium to subnormal levels. If the symptoms are acute and severe, for example painful cramps or laryngeal spasm, 20 millilitres of 10 per cent calcium chloride or calcium gluconate should be given intravenously. Calcium gluconate may be given intramuscularly. It is of course illogical to give parathormone which increases the rarefaction of bones but it may be used in an emergency; it acts within thirty minutes when given intravenously, and within a few hours when injected intramuscularly. After emergency treatment, calcium chloride, calcium lactate or calcium gluconate powder should be given by mouth, 12 grammes daily. Calciferol is also effective (50,000 units daily). After a few days or weeks the remaining parathyroid tissue usually undergoes compensatory hypertrophy, and no further treatment is required; but sometimes there is a tendency to persistent mild tetany with paraesthesia.

Secondary hyperparathyroidism—There are two types of secondary hyperparathyroidism: 1) renal osteitis fibrosa cystica with bone disease, rarefaction, deformity or fracture; and 2) acidosis nephrocalcinosis.

* Every case of renal calculi seen at the Mayo Clinic is specially investigated for hyperparathyroidism.

Renal osteitis fibrosa cystica was described by Albright in 1936 as a syndrome of primary renal insufficiency, osteitis fibrosa generalisata of all bones, enormous enlargement of all parathyroid tissue, calcium deposits in the neighbourhood of joints, calcification of the media of all arteries, marked acidosis, and high serum-phosphorus with normal or slightly reduced serum-calcium values. He pointed out that so-called " renal rickets of children " before the epiphyses are united is essentially the same disease. The condition is quite different from primary hyperparathyroidism with secondary renal insufficiency, and it is therefore useless and wrong to attempt removal of the hyperplastic parathyroid glands as their hyperplasia is an endeavour to get rid of the retained phosphorus.

Acidosis nephrocalcinosis was first described by Butler and his colleagues in 1936. It is also termed " nephrocalcinosis associated with hyperchloraemia and low plasma bicarbonate." The essential lesion is probably a renal tubular disorder which impairs the ability of the kidneys to excrete mineral acids, especially the chloride radicle; and there is therefore increased calcium loss in the urine and a negative calcium balance. The serum-calcium is normal and the serum-phosphorus is low. It is postulated that the hyperparathyroids undergo hyperplasia by which to compensate the renal insufficiency and to correct the tendency to low serum-calcium. One girl aged thirteen years showed the clinical signs of persistent rickets and dwarfism; another girl of fifteen years was unable to walk and had suffered from rickets and spontaneous fractures since the age of fifteen months. Multiple renal calculi consisting of calcium and phosphorus are a frequent but not invariable finding. The condition has been compared to that described by Fanconi as resistant rickets in children associated with acidosis and renal glycosuria. The necessary treatment is to give alkalies such as sodium citrate, and calciferol has also been used with apparent benefit.

Segmental osteoporosis (Albright's syndrome)—In 1937 Albright and his colleagues described a syndrome characterised by multifocal areas of osteitis fibrosa, patchy cutaneous pigmentation, and sexual precocity in females. Sexual precocity has since been described also in males but it is not a constant feature (Falconer and Cope 1942). The facies may be acromegalic in type but the disorder is not related to acromegaly. In boys there may be gynaecomastia. Pathological fractures, gross bending or bulging deformity of the bones and radiographic evidence of osteoporosis are the orthopaedic features. The areas of osteoporosis, like the pigmentation of the overlying skin, correspond in their distribution to segmental nerves and they may be scattered in different parts of the body or be more localised. The disorder is one of childhood and the active phase appears to cease after union of the epiphyses, which may occur prematurely. No primary endocrine cause has been discovered in life or at autopsy, and an embryological defect has been postulated. The serum-calcium and inorganic phosphorus levels are normal, and the phosphatase is normal or slightly raised. The bone dystrophy is identical with a variety of " localised osteitis fibrosa " described by Lichtenstein (1938) as polyostotic fibrous dysplasia.

Osteitis deformans (Paget's disease)—The name " osteitis deformans " indicates Paget's belief that the disorder was a chronic inflammation of bone. Moehlig and Murphy (1935) suggested that there was primary involvement of the pituitary gland and that parathyroid function was involved secondarily; but their evidence, which was slight, was based largely on the role of constitutional inheritance, the alleged incidence of familial tallness, diabetes mellitus and obesity, and the minor variations in calcium and phosphorus metabolism including phases of retention associated with increased deposition in bone. From 1930 to 1934 the present writer studied a large series of cases of osteitis deformans in collaboration with the late George Riddoch and the biochemist H. D. Kay. No evidence was found of significant disturbance of the calcium-phosphorus metabolism, although minor variations were found which might have been produced by secondary parathyroid activity. Apart from the observations relating to compression paraplegia and optic atrophy the only really significant finding of this investigation was the constantly high level of plasma-phosphatase. In thirty

patients in whom the determination was made, the phosphatase was always much above normal and in most cases was more than ten times the normal. There was a rough correlation between the increase of phosphatase and the severity and extent of the disease. Increase in the enzyme alkaline-phosphatase is an indication of active bone deposition or destruction, or of both processes going on at the same time as in osteitis deformans. The main rise was in alkaline phosphatase but there was also some rise in acid phosphatase. However, the main significance of a raised acid phosphatase is in carcinoma of the prostate with or without bony metastases, the prostatic epithelium secreting acid phosphatase. This point may be of value in differentiating osteitis deformans from carcinoma of the prostate with extensive bony metastases, a differentiation that is usually obvious on clinical grounds but which sometimes leaves room for doubt.

ADRENAL GLANDS

Cushing's syndrome—The " fat, bearded, diabetic woman " of the Cushing syndrome had already been known for many years before Cushing's paper was published in 1932 (Simpson 1948). In the words of Cushing: " The disorder is characterised by a rapidly acquired plethoric adiposity affecting the face, neck and the trunk, the extremities being spared. It is associated in women with hypertrichosis and amenorrhoea. Other characteristic features are vascular hypertension, purplish *striae distensae* of the abdomen, and acrocyanosis with cutis mammorata of the extremities. It is often accompanied by hyperglycaemia, and a peculiar softening of the bones of the skeleton has been commonly found at autopsy. In its extreme forms, the malady has often been encountered in young adults, and the average duration of life in the fatal cases has been something over five years."

The essential lesions are hyperplasia or neoplasia of the adrenal cortex and hyalinisation of the basophil cells of the pituitary. The main biological disorder is over-secretion by the adrenal cortex of the 11-oxysteroids (S-hormone of Albright). Radiographically the bones are rarefied as in hyperparathyroidism; but the essential mechanism is different. S-hormone is a catabolic hormone causing breakdown of protein with release of glucose, anabolism of protein being prevented so that the laying down of osteoid tissue is discouraged. Albright (1947) advised limitation of the term osteoporosis to this defect, and was against its more general application to other types of bone rarefaction. There is no actual defect of calcification of the osteoid matrix but there is a negative calcium balance, with increased calcium excretion in the urine and occasionally scattered deposits of calcium in the kidneys. Experimentally a comparable rise in urinary calcium excretion can be produced by the injection of adrenocorticotrophic hormone (A.C.T.H.) and there is no evidence to suggest that the parathyroids are involved in Cushing's syndrome. The serum-calcium and phosphorus are normal; the phosphatase is often normal but occasionally it is raised. Clinically there is bending of the bones, kyphosis, round shoulders and lessening of height. Severe low backache may be due to compression or spontaneous fracture of the vertebrae; and pathological fractures may also occur in the ribs, clavicles or long bones.

Many patients with these symptoms and signs are first seen by orthopaedic surgeons, and it should not be assumed that the basic endocrine disorder will always be obvious. There are indeed many intermediate grades between so-called normality and the Cushing syndrome in its classical form. A correct diagnosis is important because, quite apart from the ultimate treatment of the basic condition, intermediate hormone therapy is available as an aid to orthopaedic measures. Thus testosterone is anabolic and it promotes retention of nitrogen and phosphorus, and reduction of the abnormal excretion of calcium. It also reduces the excessive secretion of A.C.T.H. by the hyperplastic adrenals and obviates catabolic osteoporosis (Albright 1947). The practical result is that deposition of new bone is aided and the union of fractures encouraged.

Cortisone and A.C.T.H.—The most dramatic event in the history of endocrinology in relation to general medicine and surgery, and particularly to rheumatoid arthritis and

spondylitis deformans, has been the discovery in 1949 by Hench *et al.* of the therapeutic effect of cortisone or Compound E (17 hydroxy-11 dehydrocorticosterone) and later of pituitary adrenocorticotrophic hormone (A.C.T.H.) which stimulates the adrenal cortex to secrete a cortisone-like substance, most probably Compound F (17 hydroxy-corticosterone). Nothing has been so dramatic, so conclusive, or so immediately accepted as valid; the clinical evidences of recovery have been confirmed by positive tests such as fall in the sedimentation rate and decrease of eosinophils in the blood. Unfortunately cessation of treatment is usually followed by relapse, and continued treatment may give rise to such complications as the Cushing syndrome. Moreover there are still great difficulties, apart from that of cost, in synthesizing cortisone in sufficient quantity. The production of adrenocorticotrophic hormone by extraction from the pituitary glands of cattle is, however, yielding good supplies which will probably be available more generally in the near future. In spite of these difficulties and therapeutic limitations, the biochemical key that has unlocked the door to a new approach to rheumatic, infective, metabolic and allergic conditions holds tremendous promise and interest.

The immediate combination of circumstances that led to the discovery of cortisone was the observation by Hench and others that there was remission of rheumatoid arthritis in pregnancy and jaundice, the knowledge that the adrenal cortex underwent hypertrophy and hyperfunction in pregnancy which later was shown to be associated with definite increase in the secretion of cortisone, and the fact that Compound E had been isolated by Kendall at the Mayo Clinic in 1935 and was available. It has been suggested that the many years of pioneer work of Hans Selye of Montreal, and his thesis of the pituitary-adrenal mechanism in an "adaptation syndrome" initiated by injury, infection or other stresses, was the background upon which this idea of Hench and Kendall fertilised; but I see no reason to assume this at all, important though the work of Selye undoubtedly is. Hench and Kendall made a pragmatic therapeutic approach, made possible by continuous work on the adrenal gland (particularly in Addison's disease) that went back to the days of Rowntree and Snell and was accelerated by Swingle and Pfiffner's preparation of a potent cortical extract in 1929. After this discovery, which produced dramatic results in the treatment of Addison's disease in 1929 and 1930, the biochemical department of the Mayo Clinic set out to isolate and synthesize a series of steroids from the adrenal cortex. In this way Kendall's Compound E became available to Hench who had devoted his life to the study of rheumatoid arthritis. Thus the holism of medicine and surgery was illustrated dramatically.

Technique of therapy—Cortisone can be given once daily by intramuscular injection; 100 milligrams daily has proved effective whereas 50 milligrams has not, although later work by Boland and Headly (1949) suggests that 50 milligrams on alternate days may be effective in mild cases. Adrenocorticotrophic hormone can also be injected daily in 100-milligram doses. The first patient treated with cortisone by Hench and Kendall was a woman, aged twenty-nine years, with stiff, tender, swollen joints and a limp. In a few days the articular symptoms and signs had almost completely disappeared and movements were free; the patient felt well and even euphoric; her appetite improved and there was gain in weight. All the symptoms returned within a few days of cessation of the injections. Stillman and Bayles (1950) found that A.C.T.H. was effective in the crippling form of juvenile rheumatoid arthritis known as Still's disease, but there was relapse when treatment stopped. Gouty arthritis and psoriasis-arthritis are also benefited dramatically (Sprague and Power 1950). The crippling disorder of spondylitis deformans has responded to cortisone or A.C.T.H. (Boland and Headley 1949).

Although a great deal of biological and biochemical work has been done, little is known of the therapeutic mechanism of the action of cortisone, or of Compound F produced by stimulation of the adrenal cortex by A.C.T.H. With 200 milligrams of cortisone given daily for fourteen days, Sprague and Power (1950) found that there was initial retention of sodium and chlorine followed by increased excretion; and that hypochloraemic, hypokaleamic

alkalosis developed such as exists in Cushing's syndrome, associated with increased excretion of potassium. Similar results were obtained by the injection of A.C.T.H. in daily doses of 100 milligrams, with a consequent negative balance for nitrogen and potassium. Cortisone decreased the excretion of 17-ketosteroids and reduced the serum albumin-globulin ratio to normal if the serum-globulin was relatively raised before treatment. Cortisone produced a diabetogenic effect in some patients and a greatly increased insulin-requirement in pre-existing diabetes. A.C.T.H. had similar effects to that of cortisone; it caused increased secretion and excretion of cortisone-like substances, mainly Compound F, and there was some increase in urinary 17-ketosteroids. With both cortisone and A.C.T.H. the increased excretion of potassium, and the lowered serum potassium, interferes seriously with the normal mineral balance of the body and may give rise to muscular and cardiac weakness.

Selye (1949) has shown that arthritis induced in rats by the injection of formalin or of the salt-retaining hormone deoxycortone can be prevented or alleviated by cortisone or A.C.T.H. He suggests that there is antagonism between the mineralo-corticoids (deoxycortone) and the 11-oxy-corticoids (cortisone), both of which are secreted by the adrenal cortex. There is no evidence, however, of a relative or absolute deficiency of secretion by the adrenal cortex of cortisone or Compound F in patients with rheumatoid arthritis. Green (1950) believes that A.C.T.H. and cortisone act by preventing mitosis of cells, including the lymphocytes and antibody-producing reticulo-endothelial cells, thus abolishing antigen-antibody reaction and a resulting inflammatory reaction.

THE PITUITARY AND GROWTH

Clinical accounts of gigantism go back many centuries, and the term "*acromégalie*" was used by Pierre Marie in 1866. Minkowski indicated the possible association of acromegaly with the pituitary gland in 1887, and Benda showed the significance of eosinophil cells in 1900. Cushing and Davidoff (1927) demonstrated clearly that an eosinophil adenoma was the cause of gigantism and acromegaly, and they introduced appropriate surgical measures. Conversely, destructive lesions such as craniopharyngioma came to be associated with a type of dwarfism and infantilism; and biological knowledge of the influence of the pituitary on skeletal growth was consolidated by the results of experimental hypophysectomy in animals. Li and Evans (1944) isolated a crystalline form of "pure growth-hormone" from the pituitary gland, free from adrenotrophic, thyrotrophic and gonadotrophic contaminants. Its main actions were retention of nitrogen and reactivation of cartilage-cell division in the epiphyses of long bones of hypophysectomised animals, resulting in skeletal growth. Pure growth-hormone was found to have an insulotrophic and diabetogenic action in animals (Marx, Herring and Evans 1944; Cotes, Reid and Young 1949); but a specific action of insulin on epiphysial cartilage, comparable to that of growth-hormone, has not yet been demonstrated. It should be mentioned in passing that Duraiswami in Liverpool (1950) has demonstrated very recently that the introduction of a single injection of insulin into chick-embryos produces conditions similar to osteogenesis imperfecta, spina bifida, congenital pseudarthrosis, and other abnormalities. From the clinical angle, pure growth-hormone has proved disappointing in endocrine dwarfism; the commercial extracts are seldom helpful and even then only massive painful doses have been of value (Simpson 1950). Methyl testosterone, on the other hand, has dramatic effects on growth and weight in infantilism, and thyroid is sometimes useful. Both gigantism and acromegaly may be associated with enormous strength from the hypersecretion of androgens by hyperplastic and often nodular adrenal glands, the hypertrophy of the glands being secondary to a pituitary adrenotrophic stimulus. A phase of muscular weakness may arise, either from spontaneous degeneration of an eosinophil adenoma or a hyperplastic pituitary gland, or from deep radiation or surgical extirpation. It is important to realise that such measures may lead to the opposite condition of panhypopituitarism; but, if this is recognised, muscular asthenia

or cachexia will respond dramatically to testosterone to which thyroid may be added later. Mild or moderate gigantism and acromegaly occur very often as a genetic, familial or ethnological manifestation, without any major pituitary lesion. The patients are tall, strong and thick-boned; and the women may suffer from a degree of hirsutism associated with secondary hyperplasia of the adrenal cortex. They are usually good athletes and able, active "go-getters."

SEX HORMONES

The chief causes of osteoporosis, using the term in the sense of a primary lack of bone matrix formation, are: 1) disuse atrophy from long periods of bed-rest, inactivity or over-fixation in plaster; 2) post-menopausal changes; 3) old age in both sexes—described as the post-adreno-pausal condition by Reifenstein and Albright in 1947; 4) malnutrition; 5) Cushing's syndrome; and 6) idiopathic osteoporosis, of which little is known. In disuse atrophy there is absence of the normal stimulus to osteoblastic activity. In malnutrition the protein requirements are not fulfilled and there is a low concentration of serum-albumin, one of the important nitrogenous precursors of bone matrix. After the menopause there is marked deficiency in secretion of oestradiol; Albright has concluded that oestrogens are a direct stimilant to osteoblastic activity and that decreased secretion is responsible for post-menopausal osteoporosis. In these cases oestrogens cause decrease in the urinary excretion of calcium and phosphorus, and fall in the serum phosphorus if it is already raised, and there is no definite change in the urinary nitrogen or the serum alkaline phosphatase; androgens decrease the urinary calcium and phosphorus in post-menopausal osteoporosis and produce retention of nitrogen; progesterone shows no constant effects. Clinically it is advisable to use both oestrogens and androgens given as ethinyl oestradiol, 0·05 milligrams, and methyl testosterone, 10 milligrams twice daily. Apart from the apparently favourable effect on osteoporosis, pain in the bones and accelerated healing of fractures, there is improvement in the sense of well-being, and in general nutrition and appearance. Radiographic evidence of improvement usually lags behind clinical evidence. The significance of oestrogen deficiency is shown in the greater frequency of osteoporosis in women in the fifth and sixth decades, but in old age both sexes are affected because there is then a fall in the secretion of androgens by the adrenal cortex. Testosterone therapy is therefore appropriate and helpful. Excessive dosage, however, may lead to fluid retention and cardiac embarrassment (Simpson 1950).

Sexual precocity and growth—Sexual precocity in males from excessive secretion of androgens by the testes (primary, or secondary to hypothalamic-pituitary lesion), or from an adrenal neoplasm, is associated with augmentation of skeletal growth which may exceed the growth of normal controls by many inches, but with earlier appearance of epiphysial centres and premature epiphysial closure so that the ultimate height may be well below that of a normal adult. This is true of pseudo-sexual precocity in girls from secretion of androgens by an adrenal tumour or a virilizing ovarian tumour; but it is also true of sexual precocity with premature menstruation and breast development associated with an ovarian granulosa cell tumour, or bilateral cystic ovaries due to a premature pituitary gonadotrophic stimulus. It therefore seems reasonable to conclude that both oestrogens and androgens cause augmented skeletal growth, premature appearance of epiphysial centres, and premature epiphysial union.

Subgonadism—I have used this term to indicate defective or delayed sexual development and to include a number of endocrine disorders of which subgonadism, hypogonadism or agonadism is a major feature—for example, infantilism, Fröhlich's syndrome, panhypopituitarism (chromophobe adenoma or craniopharyngioma in childhood), eunuchoidism and ovarian agenesis. Infantilism may be idiopathic; it may be hypothalamic (e.g., post-concussive or from measles-encephalitis); or it may be secondary to a destructive pituitary or parapituitary lesion, secondary to chronic infection, chronic diarrhoea or metabolic disorders such as diabetes mellitus, diabetes insipidus, von Gierke's glycogen disorder and renal rickets, or secondary to congenital and rheumatic heart disease.

From the orthopaedic angle subgonadism, and particularly infantilism, is associated with retarded growth, delayed union of the epiphyses, a tendency to slender rather than stout bones, weakness of muscles, and weakness or laxity of ligaments. The biological cause appears to be defective secretion of androgens, both testicular and adrenal. In girls, the defective oestrogen secretion is important in regard to bone-age and epiphysial union; but defective adrenal and androgen secretion is the other important factor. This latter is not true of all forms of hypogonadism. The patients are generally not strong or muscular (in contrast with uncomplicated dwarfism where there may be great physical strength as, for example, in achondroplasics), and they are therefore not good at recreational activities requiring such strength—a fact that should be better recognised by games-masters in schools. There is also a tendency to slipping and displacement of the head of the femur, sometimes bilateral, which I have described previously (Simpson 1948). More often this happens when hypogonadism is associated with considerable adiposity, and there is no doubt that the excessive weight, clumsy gait and imperfect balance are important factors. Nevertheless, since it may occur in infantilism with subnormal weight it would seem that the more important factor is the hypogonadism.

One boy was sent to me in May 1947 at the age of sixteen years for failure of puberty development. His height was just under 60 inches and his weight was 80 pounds; the penis and testes were small and there was no secondary hair. A diagnosis of idiopathic infantilism was made and methyl testosterone, 5 milligrams b.d., was prescribed with the idea of accelerating growth and muscular development; he had not responded appreciably to gonadotrophic hormone. Treatment was only intermittent, but after six months he had grown over an inch and put on four pounds; the epiphyses were ununited and no pubic hair had yet appeared. In the next three months it was reported by his doctor (Dr H. C. Taylor) that he had grown a further two inches and put on five pounds; but " in the middle of April 1948, he became lame with pain in the right knee. I sent him to bed and two days later while in bed he heard a crack and the right hip became intensely painful. X-rays showed badly slipped epiphyses and femoral head." The femoral head was fixed in position with a pin by Mr R. Brooks and a walking caliper was supplied. It was then decided to stop the methyl-testosterone because of the theoretical risk of unilateral growth. Six months later the left femoral head slipped, and this too was fixed by a pin. In October 1949, when I saw the patient again at the age of nineteen years, he was 65 inches in height and 109 pounds in weight. He had received no methyl-testosterone for the previous eighteen months and was still boyish in type with incomplete sexual characteristics. He was given methyl-testosterone, 5 milligrams b.d. In April 1950 he had grown a further five-eighths of an inch and was more mature sexually, and radiographs showed that all epiphyses were almost completely united. It seems very possible that in this case the initial dosage of testosterone therapy had been inadequate.

With a craniopharyngioma (Rowlands and Simpson 1942) the patient may stop growing in childhood although the epiphyses remain open in adult life because no pituitary growth hormone is then secreted. In ovarian agenesis there is also dwarfism with late union of epiphyses, so that a coincidental pituitary defect is postulated. A wide carrying angle of the forearm (cubitus valgus), osteoporosis and webbing of neck, as well as congenital morbus cordis and coarctation of the aorta, may be additional features of ovarian agenesis.

Subgonadism and adiposity—The classical Frölich syndrome is rare, and moreover the patients in the cases originally described by Frölich (1901) and Babinski (1900) had a craniopharyngioma and were not very fat. Adiposity with delayed sexual maturity and no detectable pituitary lesion, is, however, frequent. *Adipose gynandrism* (Simpson 1950) is a condition in boys of adiposity associated with height some two inches above the average, weight twice the average, delayed sexual maturity, accelerated bone-age, red lineae distensae, and a wide pelvis with waddling gait, for the etiology of which I have postulated pituitary-adrenal hyperfunction with excessive secretion of adrenal-oestrogens, fat-deposition-factors and cortisone. A comparable condition in girls with early development of matronly feminism I have termed *adipose gynism*. Adipose boys with a female type of pelvic girdle and large hips are often unsuited physically for athletics or running, quite apart from the risk of slipped

epiphysis of the femoral head. However such boys are good swimmers, as indeed are the girls, and if the adiposity is not excessive in comparison with the skeletal development they may occasionally be good cricketers and rugby forwards, especially if puberty is associated with excess of adrenal androgens.

The Laurence-Moon-Biedl syndrome occurs both sporadically and in families as a Mendelian recessive. It is characterised by adiposity, hypogonadism, mental retardation, retinitis pigmentosa and polydactyly. There is no established pathology but a marked preponderance of pituitary basophil cells have been recorded.

Sex glands and skeletal metastases—Carcinomata of the breast and of the prostate with multiple metastases have been benefited by castration, but the operation has tended to become obsolete because the results are not permanent. Nevertheless, some favourable results have been recorded. The mechanism by which relief was gained was the removal of, respectively, the oestrogen stimulus and the androgen stimulus, not only on the primary growth but also on the metastases. Since experimental endocrinology indicated that physiological castration with involution and atrophy of the gonads could be induced by testosterone in the female and oestrogens in the male, by the inhibiting effect of these hormones on the secretion of pituitary gonadotrophic hormone, it was a natural step to apply this knowledge as a hormone-therapy substitute for surgical or radiotherapeutic castration. Loeser (1940) was the first to use testosterone in breast cancer and his work has been confirmed by Adair (1949), Cade (1949) and others. Huggins (1941) was a pioneer in the use of oestrogens for carcinoma of the prostate. When the scirrhous type of carcinoma of the breast occurs in women at the climacteric, oestrogens have been used with success when androgens have not proved helpful. Clinical results substantiated the early work, and hormonal therapy is now established; bone metastases retrogress and recalcification takes place. The radiological changes are usually not obvious for many months but pain in the bones may be relieved quickly after treatment with hormones has been started. Pathological fractures ununited for several months may heal under the influence of testosterone. There comes a time, however, perhaps within a year or perhaps after several years, when there is clinical relapse no matter how great the dosage of hormones. In the case of carcinoma of the prostate it has been thought that this is due to androgen secretion by the adrenal cortex, which undergoes hyperplasia after castration; but bilateral adrenalectomy has failed to influence the course of events (Huggins and Scott 1945). It must unfortunately be concluded that there is another neoplastic factor, quite outside the power of hormone influence.

REFERENCES

ADAIR, F. E. (1949): Lancet **i,** 610.

ALBRIGHT, F. (1936): Transactions of the Association of American Physicians, **51,** 199.

ALBRIGHT, F. (1947): Annals of Internal Medicine, **27,** 861.

ALBRIGHT, F. (1948): Journal of Clinical Endocrinology, **8,** 637.

ALBRIGHT, F., BUTLER, A. M., HAMPTON, A. O., and SMITH, P. (1937): New England Journal of Medicine, **216,** 727.

BAUER, W., ALBRIGHT, F., and AUB, J. C. (1930): Journal of Clinical Investigation, **8,** 229.

BLACK, B. M. (1948): Surgery, Gynecology and Obstetrics, **87,** 172.

BOLAND, E. W., and HEADLEY, N. E. (1949): Journal of the American Medical Association, **141,** 301.

BUTLER, A. M., WILSON, J. L., and FARBER, S. (1936): Journal of Pediatrics, **8,** 489.

CADE, S. (1949): British Medical Journal, **2,** 1193.

COLLIP, J. B. (1925): Journal of Biological Chemistry, **63,** 395.

COTES, P. M., REID, E., and YOUNG, F. G. (1949): Nature, **164,** 209.

CUSHING, H. (1932): The Pituitary Body. London: Baillière, Tindall & Cox.

CUSHING, H., and DAVIDOFF, L. M. (1927): Pathology of Acromegaly. New York: Rockefeller Institute for Medical Research Monographs, 22.

DURAISWAMI, P. K. (1950): British Medical Journal, **2,** 384.

FALCONER, M. A., and COPE, C. L. (1942): Quarterly Journal of Medicine, **N.S. 11,** 121.

GREEN, H. N. (1950): British Medical Journal, **1,** 1165.
HANSON, A. M. (1925): Proceedings of the Society for Experimental Biology and Medicine, **22,** 560.
HENCH, P. S., KENDALL, E. C., SLOCUMB, C. H., and POLLEY, H. F. (1949): Proceedings of the Staff Meetings of the Mayo Clinic, **24,** 181; 277.
HUGGINS, C., and HODGES, C. V. (1941): Cancer Research, **1,** 293.
HUGGINS, C., and SCOTT, W. W. (1945): Annals of Surgery, **122,** 1031.
HUNTER, D., and TURNBULL, H. M. (1931): British Journal of Surgery, **19,** 203.
KAY, H. D., SIMPSON, S. L., and RIDDOCH, G. (1934): Archives of Internal Medicine, **53,** 208.
KENDALL, E. C. (1935): Quoted in Endocrinology, 1942, **30,** 853.
LI, C. H., and EVANS, H. M. (1944): Science, **99,** 183.
LICHTENSTEIN, L. (1938): Archives of Surgery, **36,** 874.
LOESER, A. A. (1940): British Medical Journal, **1,** 479.
MARX, W., HERRING, V., and EVANS, H. M. (1944): American Journal of Physiology, **141,** 88.
MOEHLIG, R. C., and MURPHY, J. M. (1935): Endocrinology, **19,** 515.
REIFENSTEIN, E. C., and ALBRIGHT, F. (1947): Journal of Clinical Investigation, **26,** 24.
ROWLANDS, R. A., and SIMPSON, S. L. (1942): British Journal of Surgery, **29,** 307.
SELYE, H. (1949): British Medical Journal, **2,** 1129.
SIMPSON, S. L. (1948): Major Endocrine Disorders. Second edition. London: Geoffrey Cumberlege Oxford University Press.
SIMPSON, S. L. (1950): British Medical Journal, **1,** 692.
SIMPSON, S. L. (1950): Postgraduate Medical Journal, **26,** 201; 417.
SPRAGUE, R. G., and POWER, M. H. (1950): Proceedings of the Clinical A.C.T.H. Conference. The Blakiston Co., Philadelphia and Toronto.
STILLMAN, J. S., and BAYLES, T. B. (1950): Proceedings of the Clinical A.C.T.H. Conference. The Blakiston Co., Philadelphia and Toronto.
SWINGLE, W. W., and PFIFFNER, J. J. (1929): Anatomical Record, **44,** 225.

PROCEEDINGS AND REPORTS OF UNIVERSITIES, COLLEGES, COUNCILS AND ASSOCIATIONS

GREAT BRITAIN

BRITISH ORTHOPAEDIC ASSOCIATION

ANNUAL MEETING, 1950

The annual meeting of the British Orthopaedic Association was held in London on October 26, 27 and 28 under the presidency of Mr S. L. Higgs.

The place of femoral lengthening in leg equalisation—*Mr D. Wainwright* (Newcastle) discussed the problem of leg equalisation in such conditions as poliomyelitis, congenital short femur and premature epiphysial fusion. He said that of the surgical methods of equalisation—epiphysial arrest, leg shortening and leg lengthening—epiphysial arrest was applicable only to a limited age group, and leg shortening had the disadvantages of interference with the sound limb and significant reduction of stature. Femoral lengthening had been a controversial subject but he considered that it had a definite place in treatment. The technique used consisted in: division of the femoral shaft by a long oblique osteotomy directed downwards and laterally; skeletal weight traction through a femoral Kirschner wire; body-weight counter-traction; and skin traction on the sound limb to prevent tilting of the pelvis. Twenty-five patients had been operated upon. The average gain in length was two inches. Complications included: delayed union—one case; stiffness of the knee—two cases; and temporary nerve paralysis—two cases. There were no vascular complications. *Mr F. G. Allan* (Birmingham) said that although single-pin traction was often very successful nevertheless in occasional cases distraction was inadequate. He preferred to use a multiple-pin screw-operated distraction machine. He agreed that knee stiffness presented a real problem.

Immobilisation osteoporosis—*Dr Harwood Stevenson* (Stanmore) had studied the radiographs of 100 patients submitted to prolonged immobilisation for various diseases and had found that the process of osteoporosis followed a typical pattern irrespective of the nature of the primary disease. The changes occurred in any immobilised limb whether or not it was the site of disease. Typical features in adults were: a zone of osteoporosis at the site of the epiphysial line; a clear zone of porosis beneath the cortex at the articular surface; and patchy areas of porosis scattered throughout the bone. The pattern was modified in children. Immobilisation osteoporosis developed rapidly and might be obvious within six weeks. But if mobility was maintained disease might be present in a limb for many months without leading to marked osteoporosis. These observations suggested that osteoporosis was a consequence of immobilisation as such rather than of disease.

Osteoporosis and epiphysial changes in diseased and immobilised limbs—*Dr H. A. Sissons* (London) had studied the gross and microscopic structure of bone obtained from osteoporotic limbs and from the site of prematurely fused epiphyses. Material was obtained after death or amputation in patients submitted to prolonged immobilisation for various diseases. Examination of trabecular structure was aided by radiographs of thin bone sections. In areas of bone atrophy trabeculae that appeared radiographically to be undergoing absorption were shown histologically to be the site of osteoclastic activity. But atypical trabeculae seen in " cystic " areas in the radiograph were represented histologically by newly formed bone in which osteoblasts were active. Thus osteoclasis and osteoblastic new bone formation proceeded concurrently. Hyperaemia was not evident. In sections from areas of premature epiphysial fusion there was disruption of the epiphysis into the diaphysis and bony bridging of the epiphysial line. Histologically there was little evidence of proliferation of the remaining cartilage cells. The evidence suggested that the process of atrophy occurring during immobilisation was one of osteoporosis in the strict sense of the word, and was not simply a halisteresis. The process was not due to hyperaemia alone. *Mr H. Jackson Burrows* (London) discussing the two preceding papers said that in normal bone there was a continual and balanced cellular process of absorption and laying down of bone. In disuse atrophy there was diminished replacement of bone, and sometimes increased absorption. The stimulus responsible was unknown: vascularity had little to do with it. It was noteworthy that a general stimulus might affect only local areas of bone.

Mr M. C. Wilkinson (Black Notley) thought that if tuberculous joints were treated by less stringent immobilisation the incidence of premature epiphysial fusion would be reduced. *Mr H. Osmond-Clarke* (London) said that despite the disadvantages of immobilisation in the treatment of tuberculous joints no better method was yet known.

Curve patterns in idiopathic structural scoliosis—*Mr J. I. P. James* (London) recalled that recent work in America had shown that the pattern of the curve in idiopathic scoliosis was the key to the prognosis. He reported a study of the typical features and prognosis in two curve patterns—infantile idiopathic scoliosis and primary lumbar idiopathic scoliosis. Typical features of infantile idiopathic scoliosis were: onset during the first year of life; higher incidence in boys than girls; major curve at the mid-thoracic level, usually to the left, with compensatory curves above and below; and marked vertebral rotation. The prognosis had been assessed from analysis of thirty-three cases. Exceptionally a curve that was initially slight might disappear. A few might remain stationary; but most curves progressed and led to severe deformity. Treatment was very unsatisfactory: in a few patients correction and fusion had been undertaken but correction was often impossible because of rigidity of the curves. Primary lumbar idiopathic scoliosis was commoner in girls than boys; the apex was at or near the first lumbar vertebra and the curve usually extended from the twelfth thoracic to the third lumbar vertebra. The course was benign; correction was not required. But pain, developing in middle life from osteoarthritis, was much more common in this than in other patterns of scoliosis. If not relieved by a suitable corset, fusion (without correction) might be required. *Mr H. Osmond-Clarke* (London) said that although a study of the curve patterns simplified prognosis it did not simplify treatment. Infantile scoliosis was a ferocious problem to which no solution was known. All patients with scoliosis should be segregated in specially equipped clinics and should be reviewed carefully every three months so that in the few cases that required correction and fusion the operation could be undertaken before deformity had progressed too far.

Experimental causation of congenital defects—*Dr P. K. Duraiswami* (Liverpool) illustrated experiments in which insulin had been injected into the yolk of fertilised hens' eggs. A high proportion of the chickens developed congenital deformities, which often affected the skeleton. The type of deformity depended upon the timing of the injection: thus, injection during the first two days of incubation caused defects of the vertebral column; on the third day, the feet; on the fourth to fifth days, the limbs and beak. Abnormalities that had been produced included spina bifida, scoliosis, club foot, dislocations of the knees, pseudarthrosis, osteogenesis imperfecta, achondroplasia and chondro-osteodystrophy. It seemed that the injected substance affected organs at the time of their most rapid development: there was a critical period for each organ. In a few instances deformities had recurred in the next generation. Once the tendency to deformity had been induced, deformity occurred even if subsequent development took place in an environment free from insulin, as in a tissue culture; but the development of deformity could be prevented by injection of nicotinamide and riboflavine. *Mr Bryan McFarland* (Liverpool) emphasized the importance of this work. It was of particular interest that deformities could be induced deliberately at a predetermined site; that deformities so produced could probably be transmitted to the offspring and that the transfer of the embryo to an insulin-free medium after induction of the deforming tendency did not prevent development of the deformity.

Sprung back—*Mr P. H. Newman* (London) described recent investigations into the pathology of a common clinical type of low back pain characterised by: onset in young adults, often preceded by injury; increase of pain on flexion and relief with extension; local mid-line tenderness and a palpable depression between two adjacent lower lumbar spinous processes; but no other objective findings. He believed that the underlying pathology was a disruption of the posterior intervertebral structures by a flexion injury. Healing by fibrosis occurred but full stability was not regained. Once the back had been sprung painful redisplacement might occur whenever the protective extensor muscles were off their guard. *Mr E. A. Nicoll* (Mansfield) thought that this explanation was correct in cases of intermittent pain which occurred when the muscles were relaxed. Pain after removal of a prolapsed disc through a wide exposure (with removal of one or more spinous processes) might have a similar basis. But constant low lumbar pain such as that which sometimes occurred after crush fractures higher in the spine could not be explained satisfactorily in this way.

Reconstructive surgery in infantile paralysis—*Mr Norman Capener* (Exeter), introducing a symposium on reconstructive surgery in infantile paralysis, recalled that disability might depend upon many factors which included muscular deficiency and reciprocal overaction; muscle spasm; replacement of muscles with fibrous tissue; the mechanical effect of extrinsic forces; disorders of muscular rhythm; capsular contractures; and vascular disorders leading to shortening. These must all be borne in mind in the approach to the problems of reconstruction. It was equally important that there should be a full understanding of the applied physiology of muscle and joints if the most efficient use of the remaining muscle power was to be achieved. Leverage factors,

depending upon the position of the joint and the point of attachment of muscles to bone, must be fully considered in planning muscle transplants.

Discussing some of the more important problems that had to be tackled, Mr Capener said that in paralysis of the deltoid trapezius transplants had not given encouraging results despite the fact that theoretically the transferred power should be sufficient to abduct the arm against gravity. For flexor paralysis of the elbow he generally used Steindler's operation, transposing the forearm flexor muscles from the medial epicondyle to a higher level on the humerus. Elbow flexion could be assisted by gravity if the shoulder was abducted and internally rotated: for this reason if the shoulder was arthrodesed in a patient with weak elbow flexors it should be fixed in internal rather than external rotation. In extensor paralysis of the wrist and fingers transplants were often disappointing, as compared with the same procedure for radial nerve palsy. In abductor paralysis of the hip he had studied the possibility of combining subtrochanteric displacement osteotomy with downward shift of the trochanter provided some power remained in the gluteus medius. He had found hamstring transplants useful in quadriceps paralysis.

Soft-tissue operations in the lower limb—*Mr J. P. Campbell* (Nottingham) discussed the role of soft-tissue reconstructive operations in poliomyelitic paralysis in the foot and calf. Tendon transplants alone or as accessories to joint stabilisations were of definite value. Pre-requisites to successful tendon transplantation were: free passive movement in the joint to be activated; adequate power in the muscle to be transplanted; direct attachment of the transplant to bone; and a reasonably direct course of the transplant from origin to insertion. For paralysis of the intrinsic muscles with claw toes, transplantation of the extensor hallucis longus to the neck of the first metatarsal combined with interphalangeal arthrodesis of the hallux had given satisfactory results. Paralysis of the peroneal muscles alone was treated by tarsal stabilisation and transfer of the tibialis anterior to a new insertion at the centre of the foot. Tibialis anterior paralysis was common either alone or with weakness of the other ankle dorsiflexors. It had been treated by a tendon fusion operation, all the extensor tendons being sutured together at the dorsum of the foot. At the same time the peroneus longus was transferred to the medial side. Results were satisfactory in nineteen out of twenty-four cases of moderate severity, although it was not always possible to dispense with appliances. The difficult problem of severe calcaneo-cavus deformity from weakness of the calf muscles had been tackled by a combination of soft-tissue correction of the cavus deformity (sometimes supplemented by mid-tarsal fusion) with reinforcement of the weakened calf muscles by transfer of the remaining posterior muscles to the calcaneum.

Reconstructive surgery in childhood—*Miss M. Forrester-Brown* (Bath) recalled that some years ago she had pleaded for stabilisation of deformed feet early in childhood but it had been argued against her proposal either that fusion was not obtained or that feet so stabilised did not grow. She had found these criticisms to be unfounded, for fusion was in fact obtained and—provided only the *articular* part of the cartilage was removed—growth continued. She emphasized that in cases of muscle paralysis in the leg growth was liable to be less than normal even if no operation was performed. If severe deformity was allowed to go uncorrected till adolescent life the removal of bone necessary to gain adequate correction might result in shortening greater than any that followed fusion in early childhood. It was often advisable, despite early stabilisation, to continue the use of appliances throughout the growing period to prevent recurrence of the deformity. For calcaneus deformity she had used a two-stage operation consisting first in tarsal fusion, and secondly in removing a wedge from the posterior part of the subtaloid joint, setting the foot in slight equinus and transferring any active posterior muscles to reinforce plantar flexion.

Subtalar arthrodesis—*Mr T. T. Stamm* (London) reviewed the important part played by tarsal fusion operations in stabilising paralysed and deformed feet. He emphasized that for maximal function the foot must be stable, plantigrade and not too plantar-flexed. Because of its deep mortise the ankle joint was stable even when its controlling muscles were paralysed. Similarly the small anterior tarsal joints were stable without muscle control. But the subtalar/mid-tarsal joint was rendered unstable if the controlling muscles were paralysed. It followed therefore that any foot could be stabilised by triple tarsal fusion. Because the foot was hinged behind its centre it was usually desirable to displace the foot backwards (as in the Naughton Dunn operation) as part of the triple fusion operation to prevent the tendency for the forefoot to drop downwards. For simple drop-foot the Lambrinudi type of tarsal fusion, in which an anterior wedge is removed from the subtalar joint, was very satisfactory. Reversed drop-foot or calcaneus deformity was well corrected by a reverse type of Lambrinudi procedure in which most of the bone wedge should be taken from the calcaneum. These stabilising operations were not used as widely as they deserved to be, possibly because many surgeons were unwilling to resort to the very radical exposure of the tarsal joints which he considered was an essential part of the technique.

The results after twenty years in thirty-two cases of tarsal arthrodesis were presented by

Mr A. J. Drew (London) on behalf of Mr Stamm. The operations reviewed included triple arthrodesis, Dunn's arthrodesis and Lambrinudi's arthrodesis. From the point of view of function the results were highly satisfactory, but the appearance of the foot was often less pleasing. There was freedom from pain in 74 per cent of cases.

Elmslie's operation for the calcaneus foot—*Mr J. A. Cholmeley* (Stanmore) reviewed the important features of Elmslie's operation for calcaneus deformity of the foot, which had been found to give very satisfactory results. Elmslie had given little publicity to his method which was consequently not widely known. The operation was done in two stages with an interval of six weeks. At the first stage cavus deformity of the foot was corrected by soft-tissue stripping and talo-navicular arthrodesis (in the method as originally described calcaneo-cuboid fusion was not performed but is now frequently included in the technique); and the foot was immobilised in plaster in extreme dorsiflexion. At the second stage the posterior part of the subtalar joint was arthrodesed through a posterior approach; a longitudinal strip of the tendo Achillis was attached to the back of the tibia to give a tenodesis effect with the foot in 20 degrees of equinus; and the calf muscles were reinforced by transfer of tibialis posterior, flexor digitorum longus, flexor hallucis longus and peronei longus and brevis to the back of the calcaneum.

In the discussion that followed this symposium *Mr S. A. S. Malkin* (Nottingham) said that one of the greatest problems in the reconstructive surgery of poliomyelitis was paralysis of the gluteus medius. He had been dissatisfied with the results of the various tendon transfers. In quadriceps paralysis the merits of hamstring transfers had been the subject of controversy but in his opinion they were of definite value. He did not consider that any reconstructive operation could be regarded as entirely satisfactory unless, as a result, the need for appliances was reduced or eliminated. He thought it justifiable to advise stabilisation in early childhood as advocated by Miss Forrester-Brown only if the need for appliances could be eliminated thereby. With regard to triple tarsal fusion, he was not keen on displacing the foot backwards because of the difficulty of fitting shoes. *Mr Eric Lloyd* (London) had studied the late results in two series of cases operated upon many years ago for calcaneus deformity. In the first series the Elmslie operation had been used; in the second the reverse Lambrinudi operation. There was very little to choose between the results in the two series, but there was a small margin in favour of the Elmslie operation. The problem that remained was at what age the operation should be undertaken. He considered that it should not be done in children under the age of ten years. *Mr H. H. Langston* (Winchester) felt that the better care now being given to patients in the early stages of poliomyelitis might reduce the proportion of cases requiring reconstructive operations. He had found the operations of the Lambrinudi type very useful. One disadvantage of the operation applied to drop-foot was that the narrow posterior part of the talus was permanently engaged in the tibio-fibular mortise and the resulting lateral rock impaired stability. In intrinsic paralysis transfer of the extensor hallucis longus to the neck of the first metatarsal was sometimes of value but it was important to pull the tendon down tightly before suturing it to the bone: it was possible that improvement was due mainly to a tenodesis effect. *Mr S. L. Higgs* (London) recalled that Laming Evans was able to secure remarkably good results by astragalectomy. Perhaps his success had been due to unusual technical skill, for the operation had not given such gratifying results in the hands of other surgeons. Referring to the technique of the Lambrinudi operation he considered that it was unnecessary to resort to the very wide exposure of the joints by opening out the foot as advocated by Stamm. *Mr Bryan McFarland* (Liverpool) considered that calcaneo-cavus deformity did not present a difficult problem in the adult because it was readily corrected by either the Elmslie or the reverse Lambrinudi operation provided it was properly performed. But in the child the problem presented difficulties. While it was undesirable to cut away much bone from the feet of small children it was also undesirable to condemn them to wear appliances throughout a long period of their childhood. *Mr St. J. D. Buxton* (London) agreed that it was difficult to decide at what age tarsal stabilisation should be undertaken. He preferred to defer operation till later childhood even though appliances had to be worn in the meantime. He had seen many bad results from stabilisation in early childhood. He did not favour tendon transplantations alone but they were useful as accessories to bone operations. *Mr E. S. Evans* (Alton) referred to the use of lumbar ganglionectomy as a means of improving the peripheral circulation and reducing such troublesome complications as chilblains. He considered that ganglionectomy had too often been condemned because too much was expected of it. It was true that the dramatic initial improvement in the circulation was not maintained, but the circulation never returned to a state so bad as it was before operation. His technique had included removal of the second, third and fourth lumbar ganglia. After this operation decrease of the relative shortening of the limb had been observed in one patient. He proposed to extend the operation to include the removal of the first lumbar ganglion. Through improving the circulation in the

more proximal part of the limb it was possible that a greater stimulation of growth might be achieved.

Research on the transport and multiplication of viruses—*Mr Kingsley Sanders* (Oxford) had studied the behaviour of a virus causing encephalitis in mice, with particular reference to its transport and multiplication in the body. Since the lesions produced by the virus, and certain other features of its behaviour, were closely similar to those of the virus of poliomyelitis he believed that his researches might have a bearing on the transport and multiplication of the poliomyelitis virus itself. It had already been established, he said, that the virus of poliomyelitis was able to travel along nerve fibres and that it multiplied within the central nervous system; but further knowledge was scanty and direct research with the virus of poliomyelitis was limited by the fact that the only suitable experimental animals were monkeys, which could not be easily procured in Britain. In some early experiments encephalitis virus was introduced into a muscle of the lower limb in mice: flaccid paralysis developed in the lower limb muscles of the same side. Similarly if the sciatic nerve was steeped in a solution containing the virus paralysis developed in the corresponding limb. In further experiments the development of paralysis after muscle inoculation and after steeping of the sciatic nerve in virus-containing solution was prevented by interruption of the nerve fibres proximal to the application of virus. Any of the methods of nerve fibre interruption—section, crushing, freezing, cauterisation—gave protection. These results, taken together, suggested that the virus travelled to the central nervous system along the nerve fibres. Using similar methods it had been possible to assess the rate of travel of the virus along the nerve fibre after its introduction into the muscle or nerve. Proximal travel began almost immediately after muscle inoculation and proceeded at the rate of about half a millimetre per hour.

Multiplication of the virus after its entry into the central nervous system had been studied in the hypoglossal nuclei after injection of the virus into the tongue. The nuclei were examined and assayed for virus concentration at various time intervals after injection. It was thus possible to assess the rapidity of multiplication of the virus. It was found that immediately after arrival of the virus in the central nervous system there was an initial decline in the virus concentration. After a latent period there was a very rapid increase in virus concentration. It was further shown that during the latent period virus was still present in the nuclei and that multiplication depends upon the integrity of the nerve cells. There was thus an intimate relationship between virus and nerve cell.

The susceptibility of mice to the virus according to age had been investigated. Susceptibility was very great during the first fourteen days after birth—that is, up to the time of weaning. Since the intestines of adult mice always contained the virus the development of immunity from the mother was suggested, but this hypothesis was not supported by further experiments. The cause of the development of resistance to the virus was uncertain; but it was not related to diet. It was thought possible that resistance was due to the development of a barrier in the muscle, perhaps near the neuromuscular junction; and there was some support for such a hypothesis. Similar barriers might develop in other tissues at the natural site of entry.

A dangerous type of fracture-dislocation of the foot—*Mr W. Gissane* (Birmingham) called attention to the risk of circulatory arrest in the foot after dislocation of the tarso-metatarsal joints with multiple metatarsal fractures—the Lisfranc fracture-dislocation. He believed that the bone injury was caused by excessive rotational violence rather than by direct violence. This hypothesis was supported by the fact that the injury was seldom compound; and on anatomical grounds the damage to the blood vessels could be explained best on the basis of a torsional strain. He advocated immediate operative reduction, the first step in which should be to secure accurate reduction of the medial and middle cuneiform-metatarsal joints.

Fractures of the radial head with inferior radio-ulnar dislocation—*Mr P. Essex-Lopresti* (Birmingham) described the features of an uncommon forearm injury of which he had observed two cases. The injury was a comminuted fracture of the head of the radius associated with upward displacement of the radius relative to the ulna, manifested at the wrist by dislocation or subluxation of the inferior radio-ulnar joint. It was caused by a force acting longitudinally in the axis of the forearm. In the first case the head of the radius had been excised before the true nature of the injury was discovered. Upward displacement of the radius persisted but excellent function was regained. In the second case the upward displacement of the radius was reduced and the head of the radius reconstructed.

Although the injury was uncommon its recognition was important because if the head of the radius was excised the radio-ulnar subluxation was liable to persist or increase. Reconstruction of the head of the radius after reduction of the subluxation was probably the treatment of choice; but if comminution was severe reconstruction might be impracticable. Some other method of holding the subluxation reduced would then be necessary. It was suggested as a possibility that

the head of the radius might be excised, the subluxation reduced and the reduction maintained by insertion of a prosthesis in place of the radial head.

The Birmingham type of light metal elbow-crutch and walking-stick—*Mr F. G. Badger* (Birmingham) demonstrated new types of elbow-crutch and walking-stick which have been developed at the Birmingham Accident Hospital. Both appliances were constructed of light alloy and length was adjustable by a telescopic movement. A notable feature of the elbow-crutch was a forearm clip which could be swivelled through 90 degrees. When directed upwards this formed a convenient rest upon which the patient was able to lean with his forearm while standing, the hand thus being freed for other purposes.

Pigmented villonodular synovitis—*Mr G. R. Fisk* (London) had studied six cases of pigmented villonodular synovitis and had made a full review of the literature. The condition, sometimes termed synovial xanthoma but having many other titles, was commonest in young adults and affected a single joint, usually the knee. It occurred in two forms, generalised and localised. The generalised form was often preceded by injury and was characterised by persistent swelling and effusion of the joint, findings which might suggest a tuberculous infection. Aspiration yielded a cloudy orange-coloured fluid which contained much bilirubin and was sterile on culture. Radiographs showed normal bones: but in one case a shadow, thought to be due to deposited iron-containing pigment, outlined the distended suprapatellar pouch. Pathologically, the synovium was greatly thickened and chocolate-brown in colour. In early cases the thickened villi gave a "matted seaweed" appearance. Later there was generalised thickening with formation of nodules. Histologically the main features were: proliferation of surface cells; marked vascularity; proliferation of connective tissue; intracellular and extracellular deposits of haemosiderin and lipoid; and frequent reticulo-endothelial cells. Treatment was by synovectomy, and provided removal was complete the prognosis was good.

The localised form, sometimes termed benign synovioma, occurred as a circumscribed nodule, often near the joint line. If pedunculated it might cause recurrent locking of the joint suggestive of a cartilage tear. Treatment was by excision of the nodule.

The cause of pigmented villonodular synovitis was unknown. It did not have the characteristics of an infective lesion. It was possibly neoplastic but it seemed more likely that injury was a primary factor. Possibly large particles of haemosiderin, derived from an effusion of blood, became engulfed in the synovium and could not be removed. A vicious circle of irritation, further haemorrhage and further deposition of haemosiderin might thus be set up. It was possibly significant that similar changes in the synovial membrane had been reported at operation in a case of haemophilia.

Actinomycosis of bone—*Mr V. Zachary Cope* (London) reviewed the characteristic features of actinomycosis with particular reference to bone infection. He emphasized the facts that the actinomyces found so commonly in the soil seldom caused human or animal disease and that the causative organism was almost invariably derived from the human digestive tract. The organism was often present in carious teeth and most actinomycotic visceral infections arose from that source. The organism commonly gained entrance to other tissues through an abrasion or perforation of a viscus, and might subsequently spread by direct continuity (exceptionally by the blood stream) to bone. Macroscopically the appearance of the bone lesions was variable: there might be extensive honeycombing with multiple sinus formation; or simply a periosteal reaction. Microscopically new formation of bone, often with sclerosis, was coincident with bone absorption. The bone most commonly affected was the mandible. In the spine—any area of which might be affected—actinomycosis usually attacked the superficial parts of the bone; but unlike tuberculosis it commonly involved the transverse or costal processes as well as the vertebral body. Collapse of the body was exceptional and the intervertebral disc was resistant to infection; deformity was therefore slight. Pressure on the cord or nerve roots had been recorded but was unusual. Only sixty-four cases of spinal actinomycosis had been reported. In half of them the diagnosis had not been made before autopsy. Thus the condition was missed with deplorable frequency. Diagnosis, though suggested by the clinical and radiographic findings, could be established only by detection of the organisms in the pus, which should be cultured anaerobically. Nevertheless early diagnosis was important; for if left untreated the disease proved fatal within two or three years, whereas if it was treated efficiently by very large doses of penicillin or streptomycin, supplemented by blood transfusion and general therapy, there was a good prospect of permanent cure.

In the discussion that followed *Mr M. E. Winston* (Manchester) mentioned a patient with actinomycosis of the spine whose condition deteriorated steadily despite massive doses of penicillin; but resolution occurred with dramatic rapidity within a few weeks of beginning streptomycin therapy. *Mr Stirling* (Edinburgh) thought that actimomycosis of the spine possibly occurred with greater frequency than the reported figures suggested. It was revealed, on a show of hands,

that twenty-two cases had occurred in the practice of members present. *Mr Cope* (concluding) agreed: many cases were misdiagnosed and there must be many others that were not recorded.

Internal fixation of the McMurray osteotomy with a trifin nail—*Mr Robert Roaf* (Liverpool) had devised a simple method of internal fixation of the femoral fragments after displacement osteotomy of the McMurray type. Internal fixation reduced the need for external splintage and allowed early knee movement, and he felt that it thus extended the applicability of this very valuable operation. The method consisted in driving a long trifin nail from the tip of the greater trochanter downwards and medially into the upper part of the shaft fragment. It was important that the osteotomy be high enough to traverse cancellous bone and that the nail be long enough to ensure rigid fixation of the fragments.

Controlled pseudarthrosis for fracture of the neck of the femur—*Mr E. Mervyn Evans* (Swansea) described a method of treatment for ununited fractures of the neck of the femur which was applicable to very frail patients. He recalled that when osteotomy failed to stimulate union of the fracture a relatively painless pseudarthrosis might develop at the site of fracture and might give reasonable function. He had attempted to produce such a pseudarthrosis deliberately by encouraging movement after osteotomy while ensuring fixation and union at the site of osteotomy by internal fixation. The operation consisted in removal of a 30-degree wedge of bone, with base outwards, from the subtrochanteric region of the femur and closure of the resulting gap. The osteotomy was bridged by a special nail-plate with a wide angle and relatively short blade which was directed along the trochanteric fragment towards the upper end of the greater trochanter—not across the fracture line—the plate being fixed by screws to the shaft fragment. No form of external splintage was used. The altered alignment of the upper end of the femur afforded an almost horizontal platform upon which the head fragment rested, and early movement ensured the development of a pseudarthrosis at the fracture site.

The operation had been performed in eight patients. In all of them the osteotomy united, the hip was stable and pain was only slight or moderate. The results did not compare with the best results of the more standard operations available to relatively robust patients. The method described was not advocated as an alternative to those operations when they were practicable, but it had restored reasonable function in patients who were too frail to withstand major reconstructive operations or prolonged immobilisation in plaster.

Generalised bone decalcification—*Dr C. E. Dent* (London) gave an account of some of the rarer forms of generalised bone decalcification. He classified the conditions in which generalised decalcification occurs into five groups: primary hyperparathyroidism; secondary hyperparathyroidism; osteoporosis of the "senile" type; multiple myelomatosis; and rickets or osteomalacia. His remarks were concerned mainly with the last group, and particularly with the uncommon cases of rickets or osteomalacia which were resistant to vitamin D. He considered that the primary cause in all these cases was impaired reabsorption by the renal tubules. In one type there was simply impaired reabsorption of phosphates—a low renal threshold for phosphates—with consequently a low level of phosphates in the blood and a high level in the urine. In a second type this abnormality was accompanied by a lowered renal threshold for glucose with consequent glycosuria; and this merged into a third type in which there was also impaired reabsorption of amino acids which appeared in the urine (Fanconi type; cystine rickets). These conditions were inherited. A further type, distinct from the above and not inherited, was that in which the renal tubules were unable to make ammonia and excrete an acid urine. Acidosis occurred and calcium might be deposited in the kidneys.

The skeletal changes were the same whatever the nature of the tubular insufficiency: in children (rickets) there were the typical epiphysial changes; in adults (osteomalacia) decalcification might be associated with pseudo fractures. The principles of treatment also were the same in all types. The essentials were: a high calcium intake, with an organic acid in the diet to increase calcium absorption; high doses of vitamin D to increase calcium absorption and to raise the renal threshold for phosphates; and administration of alkalis as required to control acidosis. Care was necessary to avoid vitamin D intoxication or alkalosis.

Clinical cases were shown at the Royal National Orthopaedic Hospital. *Mr D. M. Brooks* (London) showed representative cases illustrating reconstructive surgery in paralysis of the upper limb. For paralysis of the elbow flexors a pectoralis major transplant was favoured; but when the pectoralis was weak a triceps transplant or proximal shift of the forearm flexor origin was used. Residual median paralysis with impairment of flexion of the index finger had been treated by transplant of the profundus tendon of the fourth digit to the index finger, the fifth tendon being used to activate both the fourth and fifth digits. Excellent results were shown after tendon transplants for radial paralysis and sublimis transplants for opponens paralysis. *Mr R. J. Furlong* (London) showed some excellent results from digital flexor tendon reconstructions. *Mr A. W. Law* (London) showed satisfying examples of cup arthroplasty of the hip and of spinal osteotomy. *Dr D. S. McKenzie*

(London) presented patients with congenital short limbs who had been fitted with prostheses designed to accommodate the deformed limb without amputation. He thought that such "conservative" prostheses were often preferable to the conventional prostheses fitted after amputation. *Mr J. I. P. James* (London) showed patients with scoliosis treated by correction and fusion, and illustrated typical curve patterns in idiopathic scoliosis.

DINNER TO MR S. L. HIGGS

At the autumn meeting of the British Orthopaedic Association in London the President, Mr S. L. Higgs, was entertained to dinner at Kettner's Restaurant by eleven of the sixteen St Bartholomew's men who are also Fellows of the Association.

In reply to the toast in his honour, proposed by Sir Hugh Griffiths and E. A. Freeman, the President paid tribute to the name and influence of R. C. Elmslie to whom all those present owed their interest and early training in orthopaedic surgery. He recalled how, thirty-eight years before, Elmslie had been the first orthopaedic surgeon to take charge of the Orthopaedic Department at Barts, and that it was at Kettner's in 1937 that a dinner in Elmslie's honour was held by his former house surgeons on his retirement from active charge of the department.

ACTINOMYCOSIS INVOLVING THE SPINE

At the request of the British Orthopaedic Association Mr Zachary Cope has kindly undertaken to conduct a registry of this infrequent condition, so often undiagnosed during life. It is hoped that anyone who has a proved or suspected case, or unpublished records, will communicate with V. Zachary Cope, Esq., M.S., F.R.C.S., 20 Rosecroft Avenue, Hampstead, London, N.W. 3.

1951 MEETINGS

The honorary Secretary announces the following arrangements: the spring meeting will be held in Cambridge on Friday and Saturday, April 6 and 7, 1951. The annual meeting will be held in Edinburgh on Thursday, Friday and Saturday, October 25, 26 and 27, 1951.

UNIVERSITY OF OXFORD

NUFFIELD ORTHOPAEDIC CENTRE

Clinical research in poliomyelitis—At a meeting held at the Nuffield Orthopaedic Centre on April 21, 1950, Dr Ritchie Russell of the Department of Neurology, United Oxford Hospitals, read a paper on Clinical Research in Poliomyelitis. It seemed evident, he said, that poliomyelitis was threatening to become a formidable problem in Great Britain. In 1947 and 1949 we had experienced epidemics worse than any previously known and the early figures for 1950 were ominously high. The time was therefore ripe for a survey of our knowledge of the disease, of the methods of treatment we were accustomed to use and of our efforts to advance knowledge of the condition. He sensed a certain air of defeatism regarding the prospect of any great advance in the prevention of poliomyelitis in its paralytic form. "The damage is already done when we first see the patient." "What hope is there for a disease whose incidence increases as sanitation improves?" "Surely if the Americans with all their millions of dollars for research on poliomyelitis can do so little, we need not try." These seemed to express the prevailing opinions.

Dr Russell continued: I hope to show you why it is our plain duty to accept the challenge of this disease not only with vigour but with some hope. I do not intend here to praise good work that has been done, but more to emphasize the gaps in our knowledge of the disease in the hope that others may be encouraged to work on a subject which sorely needs some extra attention. There are at present several different groups of specialists working on the disease, including virologists, infectious disease physicians, orthopaedic surgeons, physiotherapists and public health officials. This may be a reasonably adequate state of affairs as far as handling the individual case is concerned; but as a background for advancing knowledge of the disease it is not very satisfactory, for the members of each one of these groups have many other interests, and have neither the time nor always the experience of other aspects of the disease to enable them to fit their piece into the whole picture in such a way as to advance research. Nevertheless some encouragement may certainly be derived from experience that has been gained.

In 1947 I decided to study the clinical features of acute poliomyelitis by carefully questioning convalescent patients with a view to detecting any predisposing factors that might influence the course of the disease.* It had become known that many patients get the disease in an abortive form for every one that becomes paralysed, and any possible clue as to the reason for this would be worth studying. For example, there were reports in the literature of fatal paralysis developing after great physical effort, and the relation of fatigue to subsequent paralysis was obviously worth

* RUSSELL, W. R. (1949): British Medical Journal, **1**, 465.

investigating. This was a very obvious piece of research which could have been carried out by anyone accustomed to collect accurate information from patients. When the results came to be analysed it was more than clear that physical activity of any kind in the acute stage of the disease was highly dangerous, while if the patient went to bed at the onset and lay quietly the chances of severe paralysis were small. A research unit from Yale University has subsequently confirmed and extended my findings in two separate epidemics in the United States of America.

Why was this simple and obvious study never done before? The reason seems to be that clinical research into this disease like many others is so much neglected that there are exciting discoveries waiting for anyone with time to give to this type of investigation. For example, our knowledge of what to do in the acute stage is vague in the extreme. We know that strict rest in bed is rational but since these patients are often highly apprehensive and very restless there is an urgent need for an experimental investigation as to the best sedatives to use. Such problems related to treatment of the acute stage should not have to be investigated first in the human cases, for it is possible that certain types of sedative or hypnotic may help the virus to destroy the nerve cell. On the other hand it is also possible that certain drugs may make the nerve cell less attractive to the virus. In general, new methods of treatment for the acute stage of the disease should always be tried on animals first. During the acute stage the margin between a slight and severe attack of poliomyelitis seems so narrow that a mere " straw " may turn a slight case into a disaster, but equally perhaps another " straw " would prevent a disaster.

Another unfortunate gap in our knowledge is with regard to the effect either of dehydration or forced hydration of the brain—we have no idea which, if either, is helpful.

It is clear that for research in this disease we need constant help from the virus experts. Take for example the work of Howe and Bodian * which indicated that if the motor nerve roots are divided the anterior horn cells at that level become resistant to the virus; add to this the fact that physical activity reduces the nerve cell's resistance to the virus, and add also the recently proved danger of immunising injections. To the clinical onlooker these facts seem to indicate the urgent need for an experimental study of all drugs which act on the nervous system with reference to their possible effect on the vulnerability of the nerve cell.

Another problem of poliomyelitis which requires further investigation concerns the use of the iron lung. There are two aspects of this problem. In the first place, which are the cases that are most worth fighting to save? Of the scores of patients kept alive by the use of the respirator in recent epidemics we have little knowledge as to the number in which this has been worth while. Here we must look for a follow-up study from the many large hospitals for infectious diseases which have handled these cases. The second aspect of the respirator problem concerns the shortage of information about the physiology of existence in a respirator. Last autumn through the helpful co-operation of the medical superintendent, I arranged for a small research group of two (Dr Margaret Taylor and Dr Eleanor Davies-Jones) to study cases of poliomyelitis at the Western Hospital, London. The electro-medical research unit (Medical Research Council) at Stoke Mandeville co-operated in the project and made it possible to study respiratory physiology in these cases. We quickly found that we were exploring uncharted waters holding many potential dangers. Life in a respirator certainly hangs by a thread. Pharyngeal secretions or vomit are a constant worry as they are liable to get sucked into the lungs with fatal consequences, while worst of all there is no easy way of telling whether the machine is working too hard or too gently. Hyper-ventilation can be highly dangerous. One of my colleagues, after twenty minutes in a respirator at average pressures, develops tetany from over-ventilation, and within an hour has become unconscious. Should this happen to a patient it is possible that, through lack of knowledge of the cause, the motor would be turned to an even higher suction with fatal consequences. Indeed it may be that many of the fatalities in respirators are due to over-ventilation. I am glad to be able to report that this aspect of the subject at least is getting some special attention in co-operation with the Medical Research Council unit at Stoke Mandeville. The need for improving existing respirator design in Britain is an urgent matter. For example, it should be possible to nurse a patient for a time at least in the prone position and so get free pharyngeal drainage; tracheotomy (impossible in the Both machine) should also be rendered feasible. An adequate apparatus should be available for maintaining respiration when the patient is removed from the respirator for nursing attention. The Oxford Inflator, if properly set, is fairly adequate for this purpose, but a suck-and-blow machine is probably better. All these matters require study on paralysed patients and are in hand at least in a small way.

The public health expert and epidemiologist have contributed greatly to our knowledge of the disease. Unfortunately however the disease gets worse as public health improves, and measures which are designed simply to avoid infection seem to be singularly ineffective in poliomyelitis.

* Howe, H. A., and Bodian, D. (1942): Neural Mechanisms in Poliomyelitis, New York: Commonwealth Fund.

Perhaps some virus antagonism could be exploited; for example, it is possible that infection with a minor virus disease might be used to antagonise the virus of poliomyelitis.

Turning to the question of rehabilitation, Dr Russell recalled that there were many differing practices—some derived from the great Sir Robert Jones's teaching, some practised by the followers of Sister Kenny, and many intermediate groups. In these days of rapid scientific progress, our knowledge of anatomy and physiology of muscle and nerve was increasing at such a startling speed that traditional ideas might have their rationale removed overnight. Moreover the newer methods of investigation made it possible to submit long-established beliefs to tests which could finally decide their true value.

Dr Russell continued: In this field I believe that anyone with the necessary time and curiosity could make a great contribution. Take for instance what Miss Kenny calls muscle spasm—not really a spasm at all but a painful resistance to stretch in the early stage. Is this ever present when the muscle is completely paralysed? As far as I know it can only occur while the muscle can still contract. But do all muscles with persistent "spasm" therefore always recover well? Apart from relieving pain are we doing anything else when we use hot packs? What drugs relax muscle spasm? Miss Kenny's treatment is specially directed to muscles showing this spasm—that is, to muscles that are not paralysed. Is this as irrational as it appears to be? These and many other questions should be easily answered by well-planned observation. Little experiments in methods of treatment in the chronic stage, unlike the acute, are perfectly justifiable, and within limits should be encouraged. What about prolonged rest in the neutral position? What is it hoping to achieve? Does it achieve it? Is anything lost by early freedom of movement under supervision? Can the strength of the trunk muscles be accurately gauged by our clinical methods of testing them while the patient is in bed? Should muscles antagonistic to weak muscles be exercised at all or should the patient rather be trained not to contract such a muscle? It should be possible to devise means which would finally answer these and many other questions.

Again we are curiously ignorant of the optimal state of stretch in which a weak muscle should be exercised, and to what extent the shortening reactions which follow fatigue may be used to prevent deformity. Is fatigue harmful and if so how is it best avoided? How can one tell when occupational therapy designed to use a weak muscle does good and when it does harm? This is a promising field for study in a large orthopaedic hospital.

Finally we must plan these patients' lives. How soon can we advise about the future or start training for a new trade? When does it become no longer justifiable to allow treatment to interfere with career? When should we tell the patient he is wasting his time by continuing treatment? These become important questions if we are to expect grave epidemics.

REGIONAL ORTHOPAEDIC CLUBS

THE LIVERPOOL REGIONAL ORTHOPAEDIC CLUB

A meeting of orthopaedic surgeons in the Liverpool region, convened by Mr Bryan McFarland, was held on February 24, 1950; out of it the Liverpool Regional Orthopaedic Club was formed, with Mr F. C. Dwyer as its first president and Mr J. P. Heron as secretary. The first clinical meeting was held at Clatterbridge General Hospital on May 31.

Clinical cases—*Mr G. T. Partridge* showed cases of claw foot treated successfully by Lambrinudi's operation; scoliosis treated by spinal fusion; and fractures of the capitellum. In the discussion on Lambrinudi's operation *Mr E. N. Wardle* said that he preferred to fuse the metatarso-phalangeal joints rather than the proximal interphalangeal joints. Discussing fractures of the capitellum, *Mr F. C. Dwyer* said that for a severe fracture, operation was always advisable even when no displacement had occurred because there was always a tear of the medial ligament and a shift of the ulna. *Mr McFarland* said that if there was no displacement the position of full flexion prevented any lateral shift, as it did also after open operation so essential for cases with displacement. *Mr Norman Roberts* advocated screw fixation of the capitellar fragment.

Mr J. G. Bickerton showed, among others, a series of patients with fractures of the calcaneum treated by compression reduction, a short period in plaster and non-weight-bearing exercises. With one exception all patients had been able to return to work within five months. The consensus of opinion, however, was against attempts at reduction and favoured treatment of the soft tissue injury and the foot as a whole rather than of the fracture itself.

SOUTH-EAST METROPOLITAN REGION ORTHOPAEDIC CLUB

A meeting of the South-East Metropolitan Region Orthopaedic Club was held in Canterbury on July 15, 1950. A wide variety of cases was shown. These included an interesting series of cases of osteomyelitis shown by *Mr F. W. T. Davies* in which sequestra had absorbed in remarkably short periods after drilling of the bone and closure of the wound under systemic penicillin cover.

CANADA

CANADIAN ORTHOPAEDIC ASSOCIATION

ANNUAL MEETING

The sixth annual meeting of the Canadian Orthopaedic Association was held at Ingonish, Cape Breton, Nova Scotia, on June 14, 15, 16 and 18, 1950, under the presidency of Dr Alexander Gibson. The scientific programme was presented on the mornings of the four days of the meeting. The afternoons were devoted to boating, fishing, golf and swimming in surroundings of incomparable grandeur.

The histophysiology of synovial joints—*Dr W. R. Harris* (Toronto) presented a summary of our present knowledge of the structure and histology of synovial joints, the interpretation of this on the basis of embryology, and the significance of known facts of structure in relation to function. Clinical cases were shown to illustrate the various phases of normal and abnormal histology.

Plantar digital neuroma (Morton's metatarsalgia)—*Dr George Pennal* and *Dr H. B. Coleman* (Toronto) reported twenty-five cases treated by resection of the plantar digital neuroma with complete cure in all but two. At least one of the imperfect results was ascribed to incomplete resection of the neuroma. Discussion centred on Nissen's* hypothesis that the lesion is produced by endarteritis of the digital artery and ischaemic changes in the nerve.

The use of Stader's splint in compression arthrodesis for infected knee joint injuries—*Dr I. W. Davidson* (Sudbury) described the management of five cases of infected compound war wounds of the knee joint complicated by intra-articular fractures treated at the 15th Canadian General Hospital in Italy in 1944 by debridement, resection of the ends of the femur and tibia, and post-operative external skeletal fixation by Stader's splint. In all cases wound healing was obtained without difficulty and solid fusion of the femur to tibia was quickly achieved. These cases had been recently reviewed. Only one had had any trouble since operation and that was due to fracture of the femur through a pin-track.

Operation for recurrent subluxation of the ankle joint—*Dr Alexander Gibson* (Winnipeg) had concluded, from a consideration of the anatomy of the lateral [fibular collateral] ligament of the ankle, that a more physiological correction of the defect causing recurrent subluxation could be gained by shortening the tendons of peroneus brevis and peroneus tertius than by tenodesis of the tendon of the peroneus brevis between fibula and talus. Two successful cases were reported. It was claimed that the operation afforded more alert muscular control.

Repair of ligaments in recurrent subluxation of the ankle joint—*Dr H. Haig* (Vancouver) described an operation for correction of recurrent subluxation of the ankle joint after injury. The anterior tibio-fibular ligament was used. Its tibial attachment was detached with a block of bone. The ligament was swung down and the block of bone implanted into the lateral surface of the talus and fixed by a screw while the foot was held in eversion. Post-operative immobilisation was maintained for six weeks. Two successful cases were reported.

Recurrent anterior dislocation of the shoulder—*Dr W. B. MacKinnon* (Winnipeg) reported the results of operative treatment in twenty-four patients with recurrent anterior dislocation of the shoulder joint treated at Deer Lodge Hospital of the Department of Veterans' Affairs. He said that separation of the glenoid labrum or fracture of the anterior glenoidal rim had been demonstrated in all but six cases. Loose bodies had been found in the joint in two cases. The operative approach was modified from that of Bankart, the coracoid process and its attached muscles being left intact. The detached anterior glenoidal rim and capsule were reattached by a stainless steel staple. When no lesion was demonstrable the anterior joint structures were plicated in the manner of the Putti-Platt operation. Intensive muscular reconditioning was begun three to four weeks after operation. There had been no recurrence of dislocation and full function had been regained in almost every case.

Congenital dislocation of the hip—*Dr Gerald L. Burke* (Vancouver) stressed the merits of early reduction and mobile treatment of congenital dislocation of the hip. The ideals were to diagnose the dislocation at birth, reduce it as soon as possible and maintain the reduction by keeping the femur abducted to approximately 90 degrees by means of a special splint which permitted a wide range of movement at the hip joint without danger of redislocation. A unique case was presented in which the dislocation had been diagnosed before birth in a radiograph of the mother and successfully treated by reduction and mobile fixation immediately after birth.

Fixation of trans-trochanteric fractures by screws—*Dr Henry Funk* (Winnipeg) presented the results of treatment of twenty-five cases of trans-trochanteric fracture in which, after reduction,

* NISSEN, K. I. (1948): Plantar Digital Neuritis. Journal of Bone and Joint Surgery, **30-B**, 84.

the fragments had been fixed by two vitallium wood-screws. He claimed that the operation, which was done under local anaesthesia, had the advantages of simplicity and speed. He advocated early operation in all cases (even though they might not recover) because of the comfort afforded to the patient and the manner in which it simplified nursing. It was not suitable for severely comminuted fractures.

The use of the Moe plate in intertrochanteric fractures of the femur—*Dr J. C. Kennedy* (London, Ontario) reported the successful treatment of 100 consecutive cases of intertrochanteric fracture by means of the Moe plate and screws. These included every patient with intertrochanteric fracture admitted between May 1945 and December 1949, except two (one died from burns complicating the fracture; the other was moribund on admission and died from cardiac failure). The technique was simple and fixation satisfactory. The only imperfection had been a varus angulation at the fracture line in a few cases. Four plates and six screws had been removed, mostly because of discomfort. There were twenty deaths in hospital: four from pulmonary embolus, five from pneumonia, three from cerebral thrombosis, four from cardiac failure and four from miscellaneous causes.

Fracture of the elbow in childhood—*Dr J. C. Favreau* (Montreal) reviewed 1,350 cases of supracondylar fracture of the humerus in children. He said that until three years ago results had been poor in 20 per cent of cases because of imperfect reduction. Even open operation had not been uniformly successful because of the lateness of the operation and the imperfections in the technique of open reduction and fixation. During the past three years a new plan of management had given better results, especially in the types of case that hitherto had constituted problems. Present management was by manipulative reduction at the earliest possible moment after fracture, and fixation in plaster from axilla to hand, a postero-lateral window being cut in the plaster. These measures were sufficient to secure good reduction and good results in 60 per cent of cases. But if the radiographs did not show satisfactory reduction, open operation was undertaken through a posterior approach. The fragments were fixed by two Kirschner wires directed obliquely upwards, one from the inner side and one from the outer side. The results were good in thirteen out of fourteen cases, though two patients had some degree of varus deformity at the elbow. The patient classed as having a poor result had considerable varus deformity and limitation of elbow movement.

Diminished density of bone—*Dr F. C. Preston* (Toronto) gave a comprehensive review of the histophysiology of bone with particular reference to the causes of diminished density. He classified the various types of diminished bone density as seen by the orthopaedic surgeon under four headings: osteoporosis, osteomalacia, osteogenesis imperfecta and osteitis fibrosa generalisata. These were illustrated by clinical cases with radiological and pathological findings.

Fibroma of bone—*Dr F. P. Patterson* (Vancouver) reported six cases of a lesion at the end of the tibia with radiographic appearances characteristic of monostotic fibrous dysplasia of bone. But histological examination showed no trace of bone structure, only whorls of fibrous tissue. Two cases had been operated upon; the remainder were under observation.

McMurray osteotomy for fractures of the neck of the femur—*Dr Gordon Petrie* (Montreal) reported twenty-five cases of ununited fracture of the neck of the femur treated by a modified type of McMurray displacement osteotomy. The desired position of the shaft was maintained by a special plate, the upper end of which was thrust into the trochanteric fragment and the lower end fastened to the shaft by screws. A screw-nail was passed through the trochanter, then through a hole in the upper end of the plate, across the fracture line and into the head of the femur. After operation a Thomas's splint was used for four weeks. The method ensured that the desired position of the fragments was maintained, permitting earlier mobility and greater assurance of sound union at the site of osteotomy. Union of the fracture occurred in many cases. There was one death.

End-results in fractures of the neck of the femur—*Dr Jean Marc Lessard* (Quebec City) reviewed fifty-five fractures of the neck of the femur which had been treated one to five years previously at the Toronto General Hospital. The evidence suggested: 1) that the obliquity of the fracture line was not a significant factor in determining whether or not union was likely to occur; 2) that good results could only be expected when reduction had secured a valgus relationship between the head and neck of the femur (the head being impacted upon the superior corner of the neck); and 3) that non-union was due to poor reduction. The treatment of non-union by nail and bone graft was often unsuccessful and might lead to avascular necrosis.

The next meeting of the association will take place in Montreal in June 1951. The officers elected for the ensuing year were: president—Dr F. A. Brockenshire (Windsor, Ontario); president-elect—Dr Graham Huckell (Edmonton, Alberta); secretary—Dr W. B. MacKinnon (661 Broadway Avenue, Winnipeg, Manitoba).

AUSTRALIA AND NEW ZEALAND

AUSTRALIAN ORTHOPAEDIC ASSOCIATION

ANNUAL MEETING

The Annual General Meeting was held in Adelaide in May under the presidency of Mr D. J. Glissan. Mr E. F. West of Adelaide, South Australia, was elected president for the ensuing year.

It was decided to establish a Register of Rare and Interesting cases of which Mr H. C. Barry undertook to be curator.

The charts used for recording muscle power in cases of infantile paralysis have been found to vary in detail at different centres, and accordingly a standard form has been prepared in the hope of its general adoption.

Having failed to secure the co-operation of manufacturers in its efforts to improve children's footwear, the Association is trying to bring about improvement by promulgating among general practitioners the basic requirements and specifications of suitable shoes in order to create a demand among the public.

The management of the flail lower limb after poliomyelitis—*Mr Eric Price* (Melbourne) defined the flail lower limb as having no useful function in the three main segments though there might be sufficient residual power in a few muscle groups to induce deformity. He advocated an orthopaedic programme with continuous treatment, preferably in the same orthopaedic service, entailing: 1) recognition of the chronic stage; 2) prevention of deformity during observation; 3) correction of established deformity; 4) leg equalisation; 5) joint stabilisation. A limb powerless at the end of six months would remain so, and—unless there was some modifying factor, such as the existence of less severe paralysis elsewhere or lack of adequate previous treatment—it was better to begin the orthopaedic programme rather than persist with physiotherapy in a false expectation of useful recovery. When the fact of a flail limb was accepted in the young child he should be allowed up and about. Adequate splintage and the maintenance of a full range of joint movement would prevent deformity. In the correction of established deformity the cardinal rule was that continuous stretching, manipulation and soft-tissue operations should precede bone resection. Retardation of growth was ascribed principally to the poor blood supply; removal of the second and third lumbar sympathetic ganglia at about the age of six years was advised. He had found bone lengthening beset with many difficulties and was inclined to agree with Wilson and Thompson* that it was unsatisfactory in the atrophic bone of these flail limbs. He considered that shortening or arrest of growth in the good limb was the most satisfactory method of leg equalisation. Planned epiphysial arrest was a simple and safe operation. In shortening the limb of an older patient by removal of bone he preferred a subtrochanteric operation with nail and plate fixation. In stabilising the flail limb security of the foot was often the first consideration and a position of slight equinus might be desirable in order to promote locking of the knee joint in extension. It was often necessary to supplement arthrodesis of the tarsus by arthrodesis of the ankle joint. Given satisfactory foot alignment most patients were able to get about fairly well with a caliper provided with a hinge at the knee. A Trendelenberg gait was not amenable to treatment. In one case arthrodesis of the hip had led to functional improvement. In cases complicated by serious weakness elsewhere, he warned against an ambitious programme for the flail limb without due regard for the body as a whole.

The bicipital syndrome—*Mr Alex. Juett* and *Mr R. D. McKellar Hall* (Perth) gave the histories of three sprained shoulders in which the main lesion at operation proved to be, in one case, a partial rupture of the long tendon of the biceps with the ends adherent to the groove, and in the other two, dislocation of the tendon from its groove. The constant findings regarded as peculiar to the bicipital syndrome were: 1) aching in front of the shoulder, with pain referred along the outer side of the biceps to the elbow; 2) tenderness over the bicipital groove; 3) pain with a scapular catch between 80 and 110 degrees when elevating and lowering the arm in the sagittal plane; 4) in the case of the dislocating tendon, a "click" could be felt, and often heard, as the arm passed from lateral to medial rotation as in bowling overarm. In shoulder injuries damage was often sustained by many components of the joint and it was difficult to decide early which, if any, should receive operative attention.

Hindquarter amputation—*Mr T. V. Stubbs-Brown* (Brisbane) reviewed five hindquarter amputations for various neoplastic conditions of bone or soft tissues about the pelvis and upper end of the femur. Two amputations had included the lateral sacral mass, and in three a part of the ilium was left. There were no operative deaths; with modern resuscitation, anaesthesia and

* WILSON and THOMPSON (1939): Annals of Surgery, **110**, 992.

antibiotics this extensive operation had lost the formidable features which earlier had confronted Gordon-Taylor,* whose writings had been the source of both inspiration and instruction. It was urged that the operation should be given full consideration for the relief of pain, even when long survival was unlikely. It was unfair to both patient and radiotherapist to expect too much from radiotherapy alone.

Calcinosis localisata—*Mr A. R. Hamilton* (Sydney) proposed this name for a localised deposit of calcium as exemplified by that occurring in the supraspinatus tendon in distinction from the more widespread calcinosis universalis and calcinosis circumscripta. Thirteen cases were described: five about the greater tuberosity of the humerus, one on the axillary aspect of the shoulder, one at the tip of the greater trochanter, one at the lateral aspect of the elbow, one on the dorsum of the foot, one on the back of the wrist, one in the region of the flexor carpi ulnaris tendon and two in the finger. The cases were characterised by the absence of other calcified deposits, by great pain and tenderness and by the disappearance of the calcium with rest or with incision.

A report of the discussions on the papers, a discussion on scoliosis and a clinical meeting will appear in the Transactions of the Australian Orthopaedic Association.

BIENNIAL PRIZE

The Australian Orthopaedic Association has inaugurated a biennial prize for an essay on an orthopaedic subject. The first award has been made to Mr Max Lake for an essay on some aspects of Paget's disease. Mr Lake graduated with credit in 1946, winning the Hinder Surgical Prize of the University of Sydney. He has since held resident posts at the Royal Prince Alfred, King George V, Brisbane General and Brisbane Children's Hospitals. At present he is Professorial Surgical Registrar in the University of Queensland.

AUSTRALASIAN MEDICAL CONGRESS (B.M.A.)

COMBINED MEETING OF SECTIONS OF ORTHOPAEDIC SURGERY AND PHYSICAL MEDICINE

The Australasian Medical Congress (British Medical Association) was held in Brisbane from May 27 to June 3, 1950. The Sections of Orthopaedic Surgery and Physical Medicine held joint meetings. In addition to two clinical meetings, held at the Brisbane General Hospital and the Mater Misericordiae Hospital, a number of papers were read.

The painful shoulder—*Mr Lennox Teece* (Sydney) enumerated the principal causes as capsulitis or periarthritis, degenerative changes in the supraspinatus tendon, rupture of the supraspinatus and fractures in the neighbourhood of the joint. Acute periarthritis should be treated by rest, sedatives and heat; later, manipulation and assisted active movements might be required. Degenerative changes in the supraspinatus tendon, if chronic, called for rest followed by active exercises; in the few patients who failed to respond excision of the acromion, including its articular surface, was indicated. In acute cases with calcification, treatment should always be conservative. Rupture of the supraspinatus tendon required suture if complete, or otherwise rest in abduction for six weeks. Fractures about the shoulder joint could usually be treated by early movement; the only one calling for open reduction was the rare type of avulsion of the greater tuberosity with much retraction of the fragment.

The stiff shoulder—*Mr Leigh T. Wedlick* (Melbourne) distinguished between acute and chronic cases, the first due to pain and spasm, and the second usually associated with periarthritis. The importance of radiography after injury was stressed. Arthritis with pain and limitation of movement in all directions called for rest and heat. In fibrositis, local tenderness was found, with limitation of those movements only which concerned the affected muscle. Rapid recovery followed procain injection, heat, massage and active exercises. Acute fulminating bursitis was treated by complete rest, and galvanism or by an ice-bag and later by graduated movements. Acute cases of tendinitis characterised by local tenderness, a " catch-pain " and by weakness in abduction were treated by procain injection, heat, active exercises and avoidance of strain. Radiological treatment might help, especially in cases with calcification. Periarthritis, characterised by progressive stiffness and pain often referred to the deltoid insertion or more widely, usually subsided in about two months with short-wave diathermy, massage and active exercises. Manipulation under anaesthesia was considered if there was no improvement in the range of movement after four to six weeks, or if improvement ceased at any stage. X-ray therapy was useful for severe and persistent pain. The commonest type of stiff shoulder was that due to periarthritis and the most valuable treatment was prevention: " A movement a day keeps adhesions away."

* Gordon-Taylor, G., and Wiles, P. (1934): Interinnomino-Abdominal (Hindquarter) Amputation. British Journal of Surgery, **22,** 671.
* Gordon-Taylor, G. (1939): A Further Review of the Interinnomino-Abdominal Operation: Eleven Personal Cases. British Journal of Surgery, **27,** 643.

Cup arthroplasty of the hip joint—*Mr John Hoets* (Sydney) mentioned severe pain in one hip and stiffness of both hips as indications for cup arthroplasty. It should not be carried out in cases of bad general health, active infection or raised blood sedimentation rate. A blood transfusion was always given at operation. Afterwards the limb should be maintained in full medial rotation. Graduated exercises began two weeks after operation and could be facilitated by slings and pulleys. Later the fixed bicycle and swimming exercises were helpful, but crutches were necessary for at least six months from the date of operation. The results were shown in moving picture films. The author considered that cup arthroplasty would prove to be almost as great a contribution to relief of suffering as the Smith-Petersen nail in dealing with intracapsular fractures of the femoral neck.

Internal fixation for recent fractures of the shafts of the long bones—*Mr Thomas King* (Melbourne) gave a critical consideration of internal fixation of broken bones, which he thought perhaps too commonly practised and which he regarded as unsuitable for children. Some ardent advocates of " no-touch " technique were foremost in advising plating or nailing of open fractures. Whatever the successes and occasional failures with experts, this was no method for routine treatment of open fractures, especially in patients with multiple injuries; it was better, if internal fixation must be carried out, to postpone it until after healing of the skin. Plating of the femur often led to an unnecessarily stiff knee. The intramedullary nail was useful in transverse fractures of the middle third of the femur in patients unsuitable for external splinting. Displaced fragments of an oblique fracture of the tibia might be screwed. Plates should not be placed on the subcutaneous surface of the tibia and might even give trouble on one of the other surfaces. Most fractures of radius and ulna, with displacement, needed operation, especially a single fracture of the radius or a Monteggia fracture of the ulna.

Physical treatment for painful feet—*Dr M. Robinson* (Ballarat, Victoria) and *Dr D. G. Wade* (Sydney) discussed the use of heat, hydrotherapy, short-wave diathermy and other physical methods. Heat was used to relieve muscle spasm and increase blood supply, a useful preliminary to massage and exercises. Faradism and galvanism were mainly reserved for the weakened muscles in paralytic conditions. In Buerger's disease, the use of a passive vascular exerciser could be combined with Buerger's posture exercises.

Papers were also read by *Dr John Lahz* (Brisbane) on operation wound infection and by *Dr M. Lake* (Brisbane) on Paget's disease.

NEW ZEALAND ORTHOPAEDIC ASSOCIATION

OFFICIAL PUBLICATION

The Editorial Boards are delighted to learn that the New Zealand Orthopaedic Association has accepted an invitation to make the *Journal of Bone and Joint Surgery* its official publication.

FIRST GENERAL MEETING

The first general meeting of the Association was held in Christchurch on September 21 and 22, 1950. The first day was given over to discussion of the constitution of the Association and other business matters and on the second day papers were read and clinical cases shown.

Compression arthrodesis of the knee—*Mr Walden Fitzgerald* (Dunedin) gave an account of six cases in which Charnley's method of fixation had been used. After operation the limb was suspended in a Thomas's splint, and at the end of the third or fourth week a non-padded walking plaster from groin to ankle was applied. At the end of the second month a walking caliper was fitted and worn for a further month. At that time, three months after operation, clinical and radiographic fusion were present in all cases. The advantages were: 1) greater certainty of bony fusion; 2) shortening of the period of incapacity from between six and nine months to three or four months; 3) avoidance of a plaster spica; 4) early walking.

Clinical effects of chondromata—*Mr Kennedy Elliott* (Wellington) discussed various cartilaginous tumours with illustrative cases. He described cases of synovial chondromatosis in which the disease process appeared self-limiting, the excised synovia showing no evidence of continuing cartilaginous metaplasia. The joint was distended with innumerable minute transradiant loose bodies; the synovial membrane was thickened and hypertrophic. Mechanical symptoms from loose bodies were absent. In one case, heat, doughy swelling and limitation of movement had caused chondromatosis of the knee joint to be mistaken at first for tuberculosis. Three cases were shown in which an inadequately removed sessile osteochondroma had recurred with accelerated growth. Other cases included chondrosarcoma secondary to Paget's disease, and malignant change in pre-existing chondromata. Radiography and biopsy alone were regarded as unreliable in diagnosis

of malignancy. Pain was the important symptom and the diagnosis was made by the surgeon in charge of the case on the sum of the accumulated evidence, clinical, radiological and pathological. In one case a chondrosarcoma of the humerus had been treated by extra-periosteal resection of the upper two-thirds of the bone and replacement by means of a fibular graft.

Malignant synovial tumours—*Mr N. W. Nisbet* (Dunedin) discussed the pathology and presented a series of cases.

Spinal fusion—*Mr Selwyn Morris* (Auckland) submitted a series of sixty-seven cases and discussed the indications and methods. All forms of massive tibial graft, either straight or angled, had been abandoned and only two forms of grafting were used: tightly packed cancellous chips or the H-shaped interlocking graft with heavy chip reinforcement. The latter method was preferred where anatomy allowed because of the infrequency of failure (only two cases of non-union or fracture out of a total of forty-one) and the much shorter period of recumbency (four to six weeks). Before a tuberculous spine was grafted, the patient should be allowed to walk in a plaster jacket for at least three months. This produced the greatest possible collapse, tested the clinical quiescence of the disease and sometimes rendered operation unnecessary. The least possible length of spine was fused—in epiphysial or disc space infections, only the two affected vertebrae. In refractory long standing cases of low back pain with sciatica, exploration of the disc space appeared unnecessary as judged by what was found. The symptoms were due to disturbance of joint mechanism, and fusion offered the best chance of cure. It was too early to assess end-results, but it appeared that the cure rate would be close on 100 per cent.

INTERNATIONAL SOCIETIES

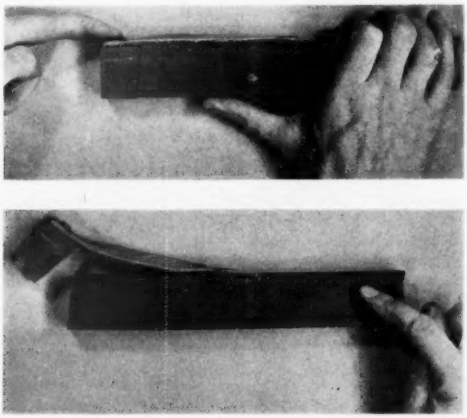
INTERNATIONAL SOCIETY OF ORTHOPAEDIC SURGERY

Sir Harry Platt, President of the International Society, and the British members hope that those attending the Congress in 1951 from the New World will be able to visit the United Kingdom on their way to Stockholm. It is proposed to arrange a short scientific meeting in London on May 16 and 17. Mr Philip Wiles, The Middlesex Hospital, London, W. 1, England, would be glad to have the names of those who intend to visit Great Britain.

Book Reviews

THE CLOSED TREATMENT OF COMMON FRACTURES. By John CHARNLEY, B.Sc., M.B., F.R.C.S., Assistant Orthopaedic Surgeon, Manchester Royal Infirmary; Visiting Orthopaedic Surgeon, The Park Hospital, Davyhulme; Lecturer in Orthopaedics, Manchester University. 10×7½ in. Pp. xi+190, with 133 figures. Index. 1950. Edinburgh: E. & S. Livingstone Ltd. Price 35s.

The author accepts the important fact that casualty officers are " on the spot " when recent fractures are admitted to hospital. Limbs then are not swollen; normal and abnormal bony landmarks are easy to distinguish. This is the time above all others for the successful manipulative



Figures 5*a* and 5*b*, illustrating the soft-tissue hinge in fractures at the extremities of long bones. (Reproduced here about three-quarter size.)

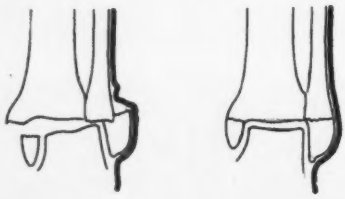
reduction of fractures, if only a picture of the complicated closed wound that is a fracture with displacement could be imprinted into the minds of all casualty officers. This book with its excellent line-drawings, radiographs and clear text goes a long way towards the achievement of this—its primary objective.

Perhaps the author, intent on making the outlines of his picture clear, over-simplifies the picture as a whole and leaves a little too much detail for the reader to work out for himself. The intact soft-tissue hinge shown in Figures 5 (*a*) and (*b*) is surely the key structure on which the manipulative reduction of most fractures should be based. Surely, too, this hinge lies somewhere on the concave side of the fracture deformity; yet the position of the hinge must be more accurately placed if the manipulator is to use it to obtain a satisfactory reduction. A Colles fracture, for example, cannot be reduced by the pure forward angulation manoeuvre: pronation is now universally recognised as an essential part of the manipulation—which suggests that the hinge is obliquely placed with its proximal attachments to the ulnar side of the radius. Again the typical backward angulation of greenstick fractures of both bones of the forearm has a very firm soft-tissue hinge on the dorsal surface of the fractures; this hinge can be easily broken by a powerful forward angular manoeuvre, but these fractures are easily and accurately reduced by a pronation

manipulation without damage to the intact soft-tissue hinge. Figure 6 suggests that the hinge in a " Pott's " fracture lies laterally, which would indicate a manipulation in adduction; yet surely the intact hinge in a " Pott's " fracture is posteriorly placed and has an oblique course from tibia to fibula indicating that a closed reduction of this fracture is by a medial rotation manipulation, using the intact hinge to pull down the posterior marginal fracture and reduce the fibular component of the ankle mortise.

The chapters on joint movement and plaster technique are very good indeed; in both, the closed wound is considered primarily as a biological problem, which is surely right. One would wish that the chapter on plaster technique were longer and that it had discussed among other things the value of dividing a plaster transversely to correct by gentle manipulation any remaining angulation, rotation or overlap deformity, with particular stress on the correction of rotation deformity by this method in fractures of the tibia. If the author desires to keep his book a small one—and there is much to be said for brevity when addressing casualty officers—then let him eliminate the Stader splint and its whole mechanical conception. If such splints are ever necessary (and after extended use I have long since ceased to use them) they should not be suggested to young casualty officers.

In this small book Mr Charnley attempts more than the education of house officers: he seeks to raise the treatment of fractures from an art to an exact science. To achieve this admirable objective we need more fundamental knowledge of the anatomy of function, of normal locomotion, of muscles working as groups and of their functional correlation with ligaments and joints. The problems still awaiting solution are chiefly of a biological nature, with recognition if possible of the essential lesion demanding treatment in any closed wound. The book contains an attractive chapter on Bennett's fracture considered as a purely mechanical problem, but it might well be that the essential lesion in this injury is a rupture of the dorsal carpo-metacarpal ligament of the thumb requiring immediate repair by open suture of the ligament alone.



Sketches (part of Figure 6) showing how it is impossible to over-reduce fractures such as the Colles or the Pott's.

The author, from Manchester, would hardly expect the reviewer, from Birmingham, to agree with his remarks on the conservative treatment of pertrochanteric fractures of the femur. In no field of surgery in the aged with which I am familiar have such universally good results been obtained as in emergency operative treatment of this fracture. We have carried it out in more than two hundred consecutive patients; it is our routine method, and there are no exceptions or refusals on our part " to be the immediate cause of a patient's demise." The average age in this series is well over seventy years and the mortality rate less than 8 per cent. Before this routine method was adopted, conservative treatment in our hands had almost twice this mortality rate. Early mobility of the aged suffering from fractures is surely another " biological principle."

In Mr Charnley's hands longitudinal traction and hyperextension of supracondylar fractures of the humerus with gross displacement is probably a safe procedure, but in less experienced hands the potential danger to the vessels in the antecubital fossa would seem real, and there is a more gentle method of reduction which does not endanger the vessels.

I have enjoyed reading this book and recommend it to all those interested in the treatment of fractures. My intention has not been to damn it with faint praise but rather to take all that it contains seriously; indeed the desire to comment on much more has had to be strongly resisted. The first edition has achieved a great deal that is very good; I hope and expect it to live through many more editions. It has set a standard for other text-books on fracture treatment to follow, if they can.—William GISSANE.

UROLOGICAL ASPECTS OF SPINAL CORD INJURIES. By George C. Prather, M.D., Department of Genito-Urinary Surgery, Harvard Medical School, Boston, Massachusetts. 9×6 in. Pp. 146, with 38 figures. Index. 1949. Oxford: Blackwell Scientific Publications. Price 27s.

The complexity of the problems encountered in cases of spinal cord injury demands the closest collaboration between the neurologist, urologist, orthopaedic surgeon and general physician or surgeon; it is therefore imperative that such cases be treated in special centres where they can be under the general charge of one man who is competent to correlate all these services and assess the importance of each aspect in the individual case. That the urological aspect is of prime importance has been shown repeatedly, particularly by the statistics from the first world war. We are of the opinion that it shares equally with the degree and extent of pressure sores in determining the severity of the illness and the ultimate fate of the patient. Urinary complications and pressure sores run hand in hand and predispose to each other. Both may be worsened by improper orthopaedic treatment, and fixation of the spine in a plaster bed or a plaster jacket should have no place in the treatment of a paraplegic. In military injuries, which are commonly produced by missiles, there is as a rule no instability of the spine, and such fixation is not required; in civilian injuries there is more often spinal displacement or instability and here the orthopaedic problem is greater. Gross displacement must obviously be corrected but the maintenance of the correction must be such as to allow the limbs to be moved passively, and the patient to be moved as a whole as easily as possible; this may be done by an arrangement of pillows and in some cases

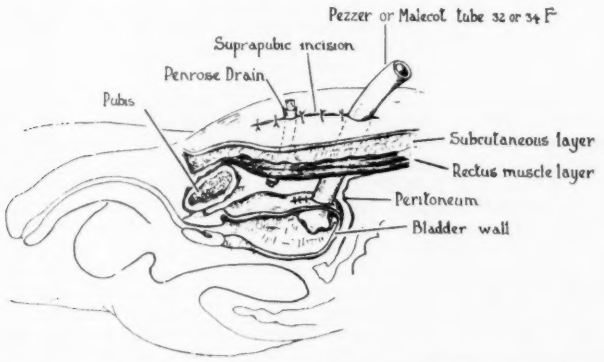


Figure 27—a line drawing to show correct placement of suprapubic tube.

a stabilising operation will be required, but plaster fixation in the paraplegic invariably leads to pressure sores.

This book deals with the urological aspects but must of necessity refer to the other sides of the problem. It opens with a consideration of the anatomy, physiology and nerve supply of the bladder. There follows a section on the changes in bladder function after spinal cord injury which is in general agreement with modern views; more consideration might perhaps be given to longitudinal injuries of the cord and the anomalous effects they produce. The methods of examination are next detailed; the author lays stress on the value of cystometry in assessing progress and points out the grave dangers of inexpert urethral instrumentation. He has made full use of cysto-urethrographic studies in observing and demonstrating dilatation of the bladder neck. In considering the care of the paralysed bladder the author quotes freely from the advocates of the various methods; the Credé method of manual expression is of limited application; intermittent urethral catheter drainage is condemned as the worst treatment that can be adopted; continuous drainage by an indwelling urethral catheter is accepted for a limited period with certain safeguards. These include expert care, a system of irrigation and a high urinary output. Suprapubic drainage is accepted as the method of choice when a long period of bladder drainage appears likely to be necessary or when there are transport difficulties. Great emphasis is rightly laid on the need for a high opening in the bladder (see Fig. 27). Any general or orthopaedic surgeon

may be called upon to perform this operation, and he must realise that correctly placing the tube may determine the success of treatment. The insertion of a suprapubic catheter does not prejudice the ultimate return of vesical function.

The changes in the upper urinary tract must be the concern of the urologist, but the orthopaedic surgeon is already familiar with the problem of recumbency calculi.

In planning for the future it is vitally necessary that all who are to be concerned in the treatment of these unfortunate patients should have ample knowledge of the problems which will be encountered. We can strongly recommend this book as giving a fair, reasoned and accurate account of the urological methods employed, and as one which is based on adequate personal experience. The book is well produced, clearly illustrated and well documented and is written in a style which makes for easy reading.—E. W. RICHES.

NEOPLASMS OF BONE AND RELATED CONDITIONS; Their Etiology, Pathogenesis, Diagnosis and Treatment. By Bradley L. COLEY, M.D., Attending Surgeon, Bone Tumor Department, Memorial Hospital for Cancer and Allied Diseases; Assistant Professor of Clinical Surgery, Cornell. 10×7 in. Pp. xiv+765, with 389 figures and 53 tables. Index. 1949. New York: Paul B. Hoeber, Inc. London: Cassell & Co. Ltd. Price £6, 10s.

This book is based on the author's experience during the past twenty-five years in the Bone Tumour Department of the New York Memorial Hospital. The clinical, diagnostic and therapeutic aspects of bone tumours are discussed in detail; but the value of the book would have been enhanced by a fuller description of the microscopic pathology, a knowledge of which is often essential to the selection of the proper method of treatment. The text is divided into eleven sections, each with an extensive and well chosen bibliography. In the first section the classification, etiology and diagnosis of bone tumours are discussed and there is an admirable chapter by Woodard on blood chemistry in the diagnosis of diseases of bone. The author advocates aspiration biopsy, and in his own clinic the method has proved remarkably accurate; but many pathologists still hesitate to give a final opinion on small fragments of tumour tissue. Other sections deal with benign and malignant tumours, tumours involving bone by extension, metastatic tumours and tumours in special localities. There are three sections on treatment and a valuable section on lesions of the skeleton simulating bone tumours.

The author's classification of bone tumours is a modification of the revised (1939) classification of the Bone Sarcoma Registry of the American College of Surgeons. He wisely rejects the artificial subdivision of osteogenic sarcoma into periosteal, medullary and subperiosteal, telangiectatic and sclerosing types, and prefers the less confusing subdivision of osteogenic sarcoma (the reviewer prefers the term "osteosarcoma"), chondrosarcoma and fibrosarcoma. But in the text no clear distinction is made between osteogenic sarcoma and fibrosarcoma, and it is confusing when the author, returning to the 1939 classification of the Bone Sarcoma Registry, uses such unsatisfactory terms as osteolytic osteogenic sarcoma and osteogenic fibrosarcoma. In the author's series of 320 benign tumours there were roughly three times as many giant-cell tumours as bone cysts. This certainly does not represent the true incidence of these two lesions, and it is clear that the Memorial Hospital is receiving a selected group of cases which present problems in diagnosis and treatment. This may account for the unusually high proportion of Ewing's sarcoma in the malignant tumours. There is now abundant evidence that Ewing's sarcoma is a rare lesion and that many tumours formerly placed in this category are metatastic tumours and undifferentiated sarcomas.

In the section on surgical treatment a detailed description is given of the technique of curettage, and of the treatment of selected cases of bone sarcoma by resection and transplantation. Amputations are discussed thoroughly, including the end-results. There is an excellent section on radiotherapy. The author advises against irradiation in benign lesions with the exception of the inaccessible giant-cell tumour. Several cases are reported in which a malignant tumour developed after injudicious irradiation of a benign lesion.

The book contains numerous illustrations, many of excellent quality, but the reproduction of some of the radiographs leaves much to be desired.—Roland BARNES.

DISEASES OF THE FOOT. By Emil D. W. HAUSER, M.S., M.D., Associate Professor of Bone and Joint Surgery, North-Western University Medical School; Attending Orthopaedic Surgeon, Passavant Memorial Hospital, Chicago. Second edition. $9\frac{1}{2} \times 6\frac{1}{2}$ in. Pp. xiii+415, with 195 figures. Index. 1950. Philadelphia and London: W. B. Saunders Company. Price 35s.

This book gives a remarkably comprehensive account of almost every disease, injury or disturbance of function that may affect the foot. The general arrangement of this mass of information is clear and orderly and a useful list of references is given at the end of each chapter; the book thus forms a most useful work of reference.

The author rightly stresses function as the primary consideration and he gives an excellent account of the mechanics of the foot and of its functions in relation to the rest of the body. The functional importance of the toes, however, is not discussed at all: they would appear to have no functions—only disabilities. The condition of claw toes associated with pes cavus is not even mentioned. Stress is laid on the supination of the forefoot that occurs as part of plano-valgus deformity, and the author has devised a metatarsal bar to be used in conjunction with an inside wedge on the heel, the effect of the bar being to tilt the forepart of the foot into pronation to help to correct this part of the deformity. Curiously, the comparable effect of congenital metatarsus primus elevatus, or of a mobile first metatarsal segment, on the posture of the foot is not mentioned; nor are these conditions considered in the etiology of hallux rigidus.

The methods of treatment advocated differ considerably from British practice, especially as regards operative and manipulative procedures, and the differences would be likely to give rise to some confusion in the minds of any but the most senior students. As a reference book, however, it can be strongly recommended.—T. T. STAMM.

PHYSIOLOGY OF MOTION, Demonstrated by Means of Electrical Stimulation and Clinical Observation and Applied to the Study of Paralysis and Deformities. By Dr G. B. DUCHENNE (of Boulogne). Translated and edited by Emanuel B. KAPLAN, M.D., Associate Orthopaedic Surgeon of the Hospital for Joint Diseases and Lebanon Hospital, New York City; Instructor in Anatomy, College of Physicians and Surgeons, Columbia University. $9 \times 6\frac{1}{2}$ in. Pp. xxiii+612, with 101 figures. Index, Appendix and Supplement. 1949. Philadelphia: J. B. Lippincott Company. Price £6, 10s.

It may seem a little hard to the busy senior orthopaedic surgeon that he should have to study physiology once again, but if he reads this book he will find it well worth his while, and the translation is so good that it is difficult to remember that it was written in French eighty years ago. I would class the book as a most interesting one for reference which should certainly find a place in everyone's collection.—Bryan MCFARLAND.

GLIEDMASS ENAMPUTATIONEN UND GLIEDERERSATZ. By W. MARQUARDT. $9\frac{1}{2} \times 7$ in. Pp. 192, with 184 figures. Index. 1950. Stuttgart: Wissenschaftliche Verlagsgesellschaft M.B.H. Price DM 28.50.

The author of each book on amputations attempts to provide the reader with the history of the subject, the indication for and methods of amputating, and more recently has added rehabilitation and a description of the types of artificial limbs used in his country. Such information is compressed into a small space in this book. The particular interest in a book from Germany is in regard to the *Krukenbergplastik* operation and the operation of Sauerbruch. Both of these are described in sufficient detail and illustrated. It is clear that they are used in selected cases and then may be useful. In this country and in the United States, where little experience of them has been gained, the double-arm amputee may have useful function with artificial limbs and in either case there is ample evidence that his adaptability is the all important factor. There are interesting remarks on gangrene from frostbite and the level of foot amputations still practised in Central Europe. Rehabilitation is on the same lines as in England, both individual and class exercises being used. The section on prostheses is of interest. The theory of weight-bearing in relation to artificial limbs is discussed. The importance of alignment in fitting is stressed and

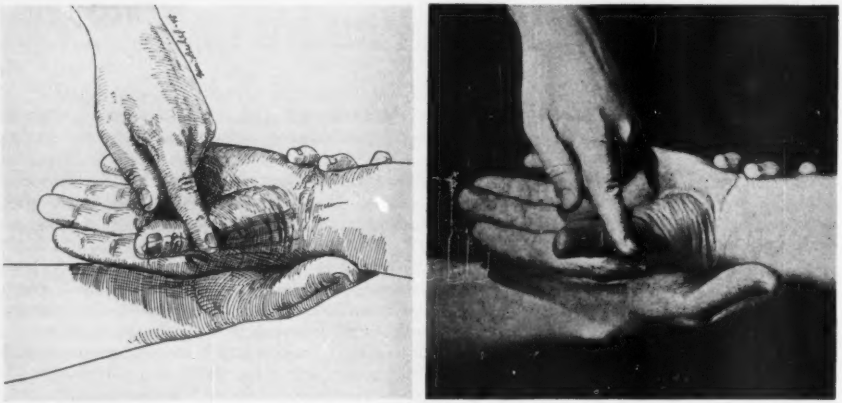
attention is drawn to Habermann's type of suction socket, two advances which are attracting attention in England to-day.

This book is well printed on good paper and the particular subjects mentioned in this review should be studied by orthopaedic surgeons and those who fit prostheses. The bibliography does not include the publications in our language since 1925.—St. J. D. BUXTON.

MUSCLES: TESTING AND FUNCTION. By Henry O. KENDALL and Florence P. KENDALL, Physical Therapy Department, Children's Hospital School, Baltimore, Maryland. $11\frac{1}{2} \times 9$ in. Pp. xi+278, with 162 figures. Appendix and Index. 1949. Baltimore: The Williams Wilkins Company. Price $7.50.

The standardisation of a system of muscle grading by the Medical Research Council in 1943 made a valuable contribution to clinical research. In poliomyelitis, as in many other neurological disorders, the accurate assessing and precise recording of muscle power are essential in order to follow progress and control treatment.

In this monograph two physiotherapists draw upon the experience of twenty-five years gained



A line-drawing and a photograph to illustrate abductor pollicis brevis. (Figures 9 and 10, reproduced here about half-size.)

in the Children's Hospital School in Baltimore. The first chapters deal with the principles of manual muscle testing and their own particular method of grading muscle power; the strength of a muscle is recorded as one of twelve grades, expressed as a percentage. To the reader in this country this classification will appear unnecessarily elaborate and divorced from reality; moreover, in an epidemic of poliomyelitis where many cases have to be examined such a complex system would be impracticable. It is doubtful whether in experienced hands the more simple 0 to 5 system is any less precise, especially as intermediate grades can be expressed by the addition of a plus or minus sign if necessary. The Kendalls employ specific charts for recording muscle power in cases of poliomyelitis and nerve injuries, but the latter charts include a host of neurological information which is hardly necessary for everyday use; a chart which can be used for all types of lower motor neurone lesions is obviously preferable. In the later chapters a series of superb photographs and diagrams illustrate the methods employed for testing individual muscles and the description is probably the most comprehensive that has yet appeared in print.

The production is first-class and these criticisms are not intended to detract in any way from a work which serves to focus attention on an important but often neglected aspect of orthopaedics. The monograph will make an instant appeal to clinician and physiotherapist alike.—Donal M. BROOKS.

OSTEOGENESIS IMPERFECTA: A Study of Clinical Features and Heredity based on Fifty-five Danish Families comprising 180 affected members. By Knud Stakemann SEEDORFF. Translated from Danish by Elisabeth Aagesen. $10 \times 6\frac{3}{4}$ in. Pp. 229, with 112 figures, 55 pedigrees and 7 tables. Paper cover. 1949. Århus: Universitetsferlaget. Price 15s.

An excellent historical review of the development of knowledge on osteogenesis imperfecta is followed by a full account of the clinical, radiographic and genetic aspects of the condition as we know it to-day. The book embodies a wealth of material from a survey of the disease in Denmark which the author carried out under the direction of Professor Tage Kemp, of the University Institute for Human Genetics at Copenhagen. Fifty-five families, including 180 individuals with osteogenesis imperfecta, were traced, and the survey is remarkable for the degree of personal study that the author brought to bear on all cases.

It is only since the end of the nineteenth century, with the help of radiological aids to diagnosis, that effective attempts have been made to sort out a variety of specific bone disorders from the all-inclusive categories of "rickets" and "osteomalacia," and it is only since then that exact knowledge of osteogenesis imperfecta and its inheritance has accumulated. But occasional examples of the disease are so remarkable that their descriptions can be recognised with some degree of certainty at far earlier periods; Seedorff records some of these from about the year 1700, and he gives in full the first account of the hereditary nature of the disease. This description, which makes a vivid and readable account of osteogenesis imperfecta even to-day, was included in a thesis on "Osteomalacia" presented in 1788 to the Faculty of Medicine in Upsala by Olaus Jacobus Ekman, the chief surgeon to the Royal Cavalry Regiment in Sweden. Ekman, to whose paper attention has been directed only recently, was familiar with most of the signs and symptoms of the disease, although he omitted any mention of its association with blue sclerotics and deafness. We learn that the name "osteogenesis imperfecta" was given to the disease by the Dutch anatomist Vrolik in 1849, and Seedorff includes Vrolik's illustration of the skeleton of a new-born infant suffering from osteogenesis imperfecta which many readers know from Julia Bell's volume on this condition in "The Treasury of Human Inheritance."

More recently the studies of M. B. Schmidt, and of Looser, on the histopathology of osteogenesis imperfecta, have, together with clinical studies, suggested the identity between the etiology of the congenital and late forms of the disease. The most recent advances in our knowledge of osteogenesis imperfecta come from the accumulation of accurate data on its inheritance, and it is here that Seedorff's own material is of greatest importance. The data from his fifty-five families are presented in adequate detail, and the occurrence of families showing both the congenital and late varieties demonstrates conclusively that these are manifestations of the same disease. The genetic aspect of the author's studies is consistent with the view that osteogenesis imperfecta in both its congenital and late forms is a disease of genetic determination; that it presents complete Mendelian dominance; and that it is not sex-linked. The responsible mutation is stated to be rare, but exact figures are not available for assessment of its frequency in the population studied by Seedorff.—H. A. SISSONS.

PYE'S SURGICAL HANDICRAFT. Edited by Hamilton BAILEY, F.R.C.S., F.R.A.C.S., F.I.C.S., F.R.S.E., Surgeon, and Surgeon-in-charge of the Genito-urinary Department, Royal Northern Hospital, London; Senior Surgeon, St Vincent's Clinic and the Italian Hospital. Sixteenth edition. $8\frac{1}{2} \times 5\frac{1}{2}$ in. Pp. x+724, with 830 figures. Index. 1950. Bristol: John Wright & Sons Ltd. London: Simpkin Marshall Ltd. Price 25s.

The transition from chrysalis to butterfly is no more sudden and dramatic than the metamorphosis of medical student into house officer. Before qualifying a man is assumed to know nothing: after qualifying, everything. No wonder he feels the need of a book of reference that will tell him the hundred and one odd facts, figures and techniques he is expected to know. For over two-thirds of a century *Pye's Surgical Handicraft* has stood him in good stead. Few medical books have had such a long life; it obviously supplies a need and while under the editorship of Hamilton Bailey is likely to maintain its unrivalled position. It would therefore be as impertinent to criticise the book as to criticise Gladstone or Churchill, but might we make two suggestions. First, the names of the authors are too well-known; the best person to write on these matters is a senior resident, not yet known outside his own hospital. And second, the book should be portable; a Pye in the pocket is worth more than a Whitaker on the bookshelf.—George PERKINS.

BOOKS RECEIVED

These books are acknowledged with grateful thanks. Selections will be made for review as space permits and in accordance with their interest for our readers.

ORTHOPAEDIC SURGERY. By Walter MERCER, M.B., Ch.B., F.R.C S. (Ed.), F.R.S. (Ed.). Fourth edition. 1950. London: Edward Arnold & Co.

JOHN HUNTER. By S. Roodhouse GLOYNE, M.D. (Leeds). 1950. Edinburgh: E. & S. Livingstone Ltd.

FUSS UND BEIN: IHRE ERKRANKUNGEN UND DEREN BEHANDLUNG. By Georg HOHMANN. 1948. München: J. F. Bergmann.

HAND UND ARM: IHRE ERKRANKUNGEN UND DEREN BEHANDLUNG. By Georg HOHMANN. 1949. München: J. F. Bergmann.

THEORIE ET PRATIQUE DE L'OSTEOSYNTHESE. By Robert DANIS. 1949. Paris: Masson et Cie.

LES MALFORMATIONS DU NOUVEAU-NE CAUSEES PAR LES VIROSES DE LA GROSSESSE ET PLUS PARTICULIEREMENT PAR LA RUBEOLE (Embryopathie Rubéoleuse). By Jean B. BOURQUIN. 1948. Paris: Librairie E. Le François.

CHIRURGIE REPARATRICE. By Professeur R. Merle D'AUBIGNE 1949. Paris: L'Expansion Scientifique Française.

B.R.A. REVIEW. Quarterly Journal of the British Rheumatic Association. Honorary Editor: A. GARLAND, M.D., M.R.C.P., D.P.H. Vol. 1., No. 1. August 1950.

STUDIES ON TUMOUR FORMATION. By the late G. W. de P. NICHOLSON, M.A., M.B., B.Ch. 1950. London: Butterworth & Co. (Publishers) Ltd.

THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS INSTRUCTIONAL COURSE LECTURES. Editor, Walter P. BLOUNT, M.D.; Associate Editor, Sam W. BANKS. Vols. V and VI. 1948 and 1949. Ann Arbor, Michigan: Edwards Bros. Inc.

SOME PROBLEMS OF ACUTE ANTERIOR POLIOMYELITIS AND ITS SEQUELAE. By Erik SKINHOJ. 1949. Copenhagen: Ejnar Munksgaard.

WERDNIG-HOFFMANN'S INFANTILE PROGRESSIVE MUSCULAR ATROPHY. By Sven BRANDT. 1950. Copenhagen: Ejnar Munksgaard.

OS ET TUBERCULOSE. By Robert KAUFMANN. 1950. Paris: L'Expansion Scientifique Française.

INJURIES TO THE ANKLE. By J. Grant BONNIN, M.B., B.S. (Melbourne), F.R.C.S. (England). 1950. London: William Heinemann Medical Books Ltd.

AN OUTLINE OF ORTHOPAEDIC PATHOLOGY. By Charles W. GILFILLAN, M.D., F.A.C.S. 1950. Los Angeles: Graduate School of Medicine, College of Medical Evangelists.

RECENT ADVANCES IN PHYSICAL MEDICINE. Edited by Francis BACH, M.A., D.M., D.Phys.Med. 1950. London: J. & A. Churchill Ltd.

POSTGRADUATE LECTURES ON ORTHOPEDIC DIAGNOSIS AND INDICATIONS. Volume 1. By Arthur STEINDLER, M.D., F.A.C.S. 1950. Springfield, Illinois: Charles C. Thomas, Publisher. Oxford: Blackwell Scientific Publications Ltd.

DEGENERAZIONE E RIGENERAZIONE DEI TRONCHI NERVOSI NELL'UOMO. By Professor Silvano LEGHISSA. 1950. Bologna: Edizioni Scientifiche Istituto Rizzoli.

INJURIES OF THE KNEE JOINT. By I. S. SMILLIE, O.B.E., Ch.M., F.R.C.S.(Ed.), F.R.F.P.S. Second edition. 1950. Edinburgh: E. &. S Livingstone Ltd.

A SYNOPSIS OF SURGICAL ANATOMY. By A. Lee McGREGOR, M.Ch., F.R.C.S. Seventh edition. 1950. Bristol: John Wright & Sons Ltd.

PATHOLOGIE DES VEINES. By J.-D. MARTINET and R. TUBIANA. 1950. Paris: G. Doin et Cie.

CHIRURGIE ET ORTHOPEDIE DU RHUMATISME. By J. J. HERBERT. 1950. Paris: Masson et Cie.

BONE AND JOINT DISEASES. By J. Vernon LUCK, M.D., M.S.(Orth.), F.A.C.S., F.I.C.S. 1950. Oxford: Blackwell Scientific Publications Ltd.

A TEXTBOOK OF X-RAY DIAGNOSIS BY BRITISH AUTHORS. Edited by S. Cochrane SHANKS, M.D., F.R.C.P., F.F.R., and Peter KERLEY, M.D., F.R.C.P., F.F.R., D.M.R.E. Second edition. Vol. 4. 1950. London: H. K. Lewis & Co. Ltd.

CAMP
TRADE MARK

Anatomical Supports

For Physiological Surgical and Orthopædic Use

Camp Surgical Supports and Belts
(equipped with Precision-fitting Adjustments)
are fitted and supplied by
Authorized Camp Dispensers
throughout the country

Camp Supports are designed for use in the treatment of physical disability, deformity or disease

Reference Book for Physicians and Surgeons available post free on request

S. H. CAMP & COMPANY LTD.
19 Hanover Square, LONDON, W.1 Tel.: MAYfair 8575 (4 lines)

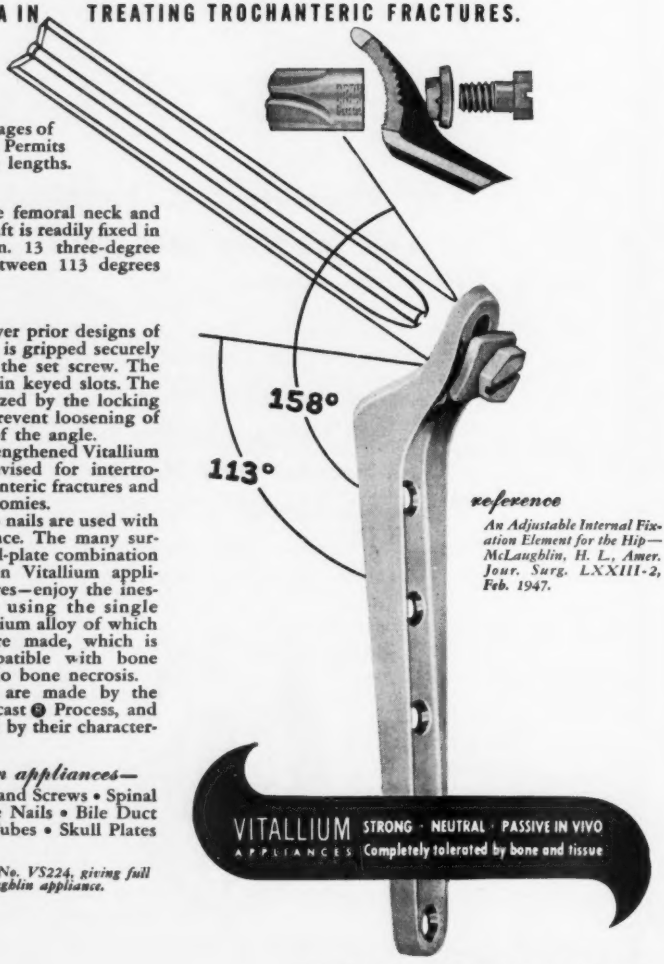
KCR 352

adjustable

the Vitallium®

Mc Laughlin Intertrochanteric Appliance

A NEW IDEA IN TREATING TROCHANTERIC FRACTURES.



EASIER INSERTION
Incorporates the advantages of nail-plate combination. Permits wider selection of nail lengths.

ADJUSTABLE
Angular relation of the femoral neck and head to the femoral shaft is readily fixed in most desirable position. 13 three-degree steps are provided between 113 degrees and 158 degrees.

POSITIVE LOCK
An improved feature over prior designs of this appliance. The nail is gripped securely by the plate teeth and the set screw. The locking collar engages in keyed slots. The set screw shaft is squeezed by the locking collar. These features prevent loosening of the screw or collapse of the angle.

This improved and strengthened Vitallium appliance has been devised for intertrochanteric and subtrochanteric fractures and for high femoral osteotomies.

Regular Vitallium hip nails are used with the McLaughlin appliance. The many surgeons who prefer a nail-plate combination can now standardize on Vitallium appliances for all hip fractures—enjoy the inestimable advantage of using the single metal, the cobalt-chromium alloy of which Vitallium appliances are made, which is inert, completely compatible with bone and tissue and causes no bone necrosis.

Vitallium appliances are made by the Austenal-devised Microcast® Process, and can be readily identified by their characteristic "satin" finish.

reference

An Adjustable Internal Fixation Element for the Hip—McLaughlin, H. L., Amer. Jour. Surg. LXXIII-2, Feb. 1947.

some other Vitallium appliances—
Hip Nails • Bone Plates and Screws • Spinal Fusion Plates • Fracture Nails • Bile Duct Tubes • Blood Vessel Tubes • Skull Plates

Send for descriptive leaflet No. VS224, giving full details of the McLaughlin appliance.

Telephone: Welbeck 0318/9

LONDON SPLINT COMPANY Ltd.

69 WEYMOUTH STREET, LONDON, W.1

A normal life—
even for the cerebral palsy victim

Due to the "telescoping" of her body this cerebral palsy patient spent almost 24 years of her life on crutches. Excessive fatigue made physical activity difficult.

In 1946 she was referred to an Orthopaedic Consultant who prescribed a Spencer Support. Spencer Designers then created a support for her based on 35 measurements and descriptions of her body *as the Orthopaedic* Consultant wanted it controlled. The result was a support that adequately stabilized the pelvis and supported the weak back and abdominal muscles to prevent "telescoping." Fatigue symptoms were relieved and her sense of well-being increased.

A recent letter relates that she now has a full-time job, is completely self-supporting—and is even learning to swim with the aid of a Spencer worn under her swimming suit!

For men, women and children, for conditions of abdomen, back or breasts, Spencer Supports are therapeutically effective because: each is *individually designed, cut, and made* to meet the medical indications of the individual patient.

For further information write to:

SPENCER (BANBURY) LTD.

Consultant Manufacturers of Surgical and Orthopaedic Supports

SPENCER HOUSE BANBURY OXFORDSHIRE

Telephone 2265

Spencer copyright designs are original and distinctive and for more than 20 years have been recognised by the Medical Profession as a symbol of effective control for abdomen, back or breasts.

BEWARE OF IMITATIONS. Spencer (Banbury) Ltd. regret the necessity of issuing warning to beware of copies and imitations. Look for the SPENCER LABEL stitched in the Spencer Support and ensure that it is a genuine Spencer Support and not a so-called copy.

Appliances supplied under the National Health Service

Trained fitters available throughout the Kingdom

Copyright: Reproduction in whole or in part is prohibited except with the written permission of S(B) Ltd.

GLASSONA
TRADE MARK

THE NEW
PLASTIC SPLINTING MATERIAL

the latest contribution
to Medical advancement by

T · J · SMITH & NEPHEW LTD

makers of

GYPSONA & ELASTOPLAST

Enquiries will be welcomed by the Medical Division of the manufacturers—

T·J·SMITH & NEPHEW LTD. HULL

A GUIDE FOR NATURE'S REPAIR OF FRACTURED BONES

EGGERS TYPE ®

VITALLIUM

INTERNAL CONTACT SPLINT

VITALLIUM ® MICROCAST PRECISION CASTINGS PROCESS

Encourages earlier bony union . . . assures optimum placement of screws . . . provides fully adequate fracture support.

Vitallium Internal Contact Splints are slotted bone plates—permitting fractured bone ends to move together and to be in constant contact under muscular pressure when necrosis and absorption of the traumatized bone ends occurs. They keep the fractured bone in longitudinal alignment and provide lateral stability. Fragments are locked securely, and rotation is hindered by the combination of longitudinal muscular pull and screw fixation.

The Eggers splints thus serve as guides for nature's repair of fractured bones. Under the influence of splinting, compression, and contact, mechanical and physiological conditions favorable to early bony union are created.

The slots in the plates facilitate placing the screws in the most desirable locations — as far from the fracture site as possible. Loose bone fragments may be engaged firmly with additional screws.

ORDER THROUGH YOUR SURGICAL DEALER

Available in lengths of 3", 4", 5" and 6" with Eggers type screws.

® BY AUSTENAL LABORATORIES, INC.

References: "Internal Contact Splint" —Eggers, G.W.N.
Jour. Bone & Joint Surg., 30-A, No. 1, Jan. 1948
"The Influence of The Contact-Compression Factor on Osteogenesis in Surgical Fractures" — Eggers, G.W.N., Shindler, T.O. and Pomerat, C.M.,
Jour. Bone & Joint Surg., 31-A, No. 4, Oct. 1949

AUSTENAL LABORATORIES, INC.
NEW YORK **CHICAGO**
SURGICAL DIVISION • **224 EAST 39TH STREET, NEW YORK 16, NEW YORK**

b1

An important development

New improved instruments for

HIP ARTHROPLASTY

As made for

MR R. BROOMHEAD, F.R.C.S.

Orthopaedic Surgeon

The General Infirmary at Leeds

Left-hand Spiral Cutting Teeth

Female Concentric Reamer for Femoral Head

Male Concentric Reamer for Acetabulum

Broomhead's Improved Smith-Petersen's Reamers for Femoral Head and Acetabulum represent the latest advance in Instruments of this type

Special features include:—

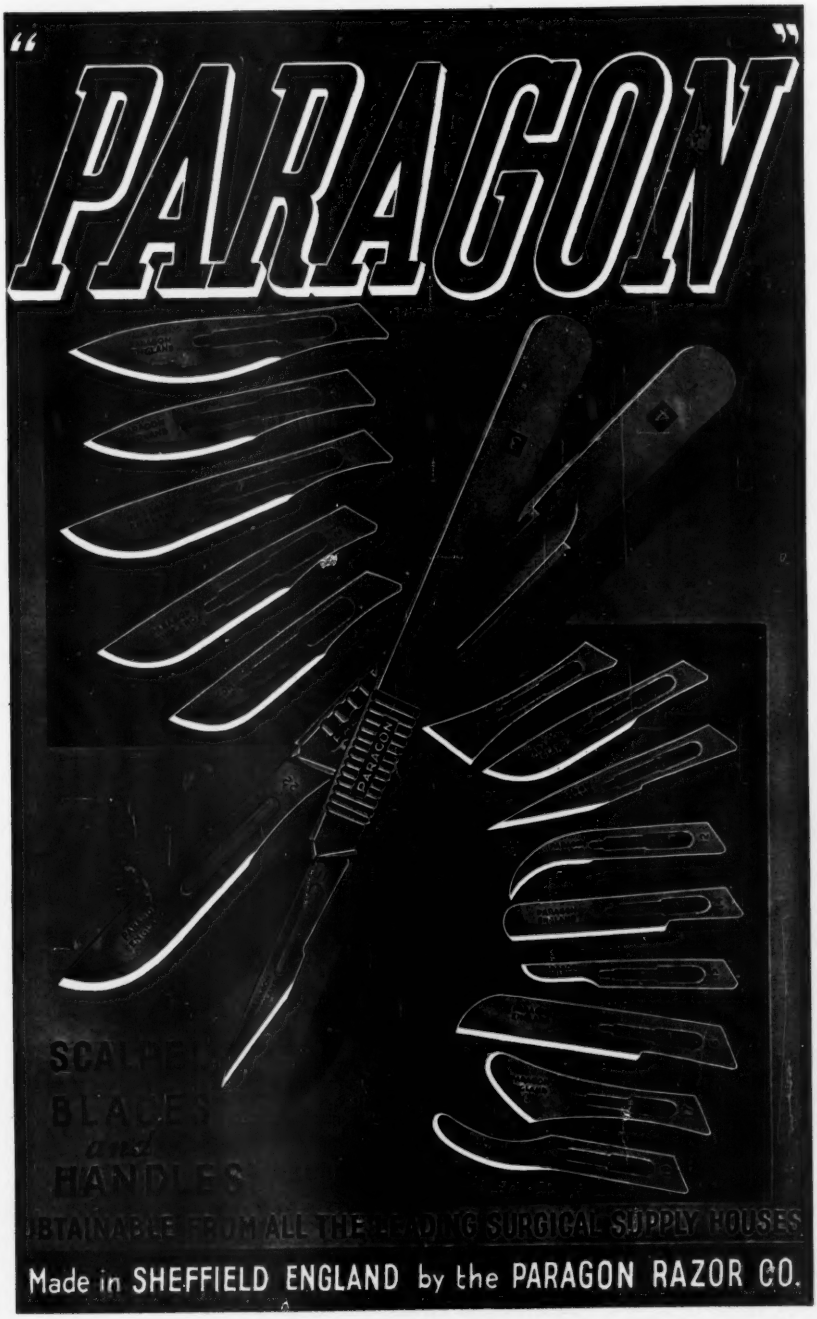
- The Left-hand Spiral Cutting Teeth automatically eject bone fragments. They are self-clearing and immune to clogging in actual use.
- Precision-made in three sizes, bearing an accurate relationship to standard Vitallium Hip Cups.
- Stainless steel and non-rusting.

Full details on request

Chas. F. Thackray LTD

Head Office:
The Old Medical School, Park St., Leeds 1
Telegrams: "Aseptic, Leeds" *'Phone:* 20085 (3 lines)
Also at 38 Welbeck Street, London, W. 1
Telephone: 8152/3
and at Cape Town

Manufacturers of Surgical Instruments, Hospital Furniture, and Sterilizing Equipment


"PARAGON"
SCALPEL
BLADES
and
HANDLES
OBTAINABLE FROM ALL THE LEADING SURGICAL SUPPLY HOUSES
Made in SHEFFIELD ENGLAND by the PARAGON RAZOR CO.

Manufacturers of Bone Surgery Instruments for over 70 Years

Jones' Gouge

Capener's Osteotome

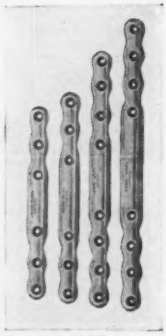
Capener Neufeld "V" Nail

Watson-Jones' tri-fin Nail

Craftsmanship

Honey's tri-fin Nail and Plate

Charnley's relf-retaining Retractors



Burns' Plates

Burns' Ulna and Radius Forceps

Charnley Knee Clamp

Howell's "Lion" Forceps

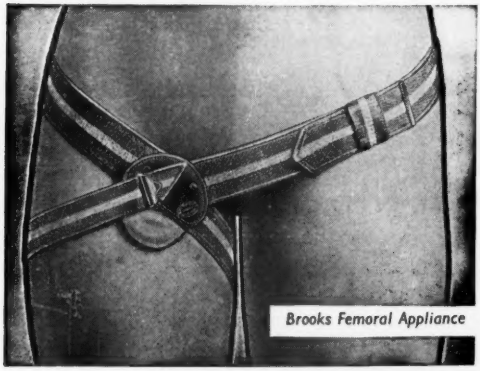
Double-action Bone Gouge

DOWN BROS. and MAYER & PHELPS LTD.

Head Office: **92–94 BOROUGH HIGH STREET, LONDON, S.E.1**
Showrooms: **32–34 NEW CAVENDISH STREET, LONDON, W.1**
and at
76 Grenville Street, TORONTO

BROOKS RUPTURE APPLIANCES★

For every known type of HERNIA



Brooks Femoral Appliance

Every Brooks appliance is carefully made to individual measurements, and is guaranteed to fit perfectly and to hold securely. In addition to the usual types (inguinal, scrotal, umbilical, femoral, etc) we also make Tropical Rupture Appliances, Bathing and Swim Trusses, Children's and Babies' Appliances and Belts of all kinds. Our range includes everything for the ruptured, and we are privileged to co-operate with an increasing number of medical men and hospitals.

Let us send you full particulars.

★ *Patented in England and thirteen foreign countries. Sold the world over.*

BROOKS Appliance Co., Ltd.

LONDON: (749C) 80 Chancery Lane, W.C. 2. Telephone: Holborn 4813.
MANCHESTER: (749C) Hilton Chambers, Hilton Street, Stevenson Square. Telephone: Central 5031.
LIVERPOOL: (749C) 66 Rodney Street. Telephone: Royal 6548.
Also at Buenos Aires, Johannesburg, Sydney, Melbourne, Calcutta, Durban, etc.

They always make me welcome

And why not? We do not regard an account as being of small consequence simply because it *is* small. On the contrary, we believe that the importance of any banking transaction lies in its importance to the customer. We try to meet our customers' requirements in that spirit and to give the same welcome and the same friendly attention to all of them, whatever the size of their accounts. If you would like to know more about the personal quality of Westminster Bank service, the Manager of your local branch will be glad to tell you.

WESTMINSTER BANK LIMITED

Putting it plainly

The carefully balanced characteristics of ILFORD X-ray films enable them to reproduce important detail clearly over the whole range of subject opacities. There are three types of ILFORD X-ray film in general use for medical radiography: Standard, Red Seal and Ilfex. Each type has certain special properties but high quality, perfect uniformity and freedom from fog are common to all.

★ *ILFORD STANDARD X-RAY FILM* for most of the routine work of the X-ray Department.

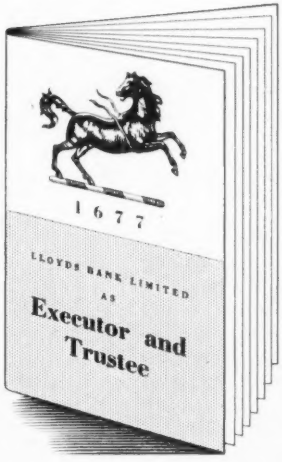
★ *ILFORD RED SEAL X-RAY FILM* for all occasions where extreme speed is needed.

★ *ILFORD ILFEX X-RAY FILM* for maximum resolution of fine detail.

ILFORD

★ *The Department of Radiography and Medical Photography of Ilford Limited, Tavistock House, Tavistock Square, London, W.C.1 (EUSton 2251), will always welcome the opportunity of helping with information or advice.*

ILFORD LIMITED · ILFORD · LONDON



A booklet to read before you appoint your Executor

The Manager of any branch of Lloyds Bank will be pleased to let you have a copy of this booklet, which provides useful information about the Bank's executor and trustee services.

LLOYDS BANK
LIMITED

For certain cases of weak (valgus) feet

Clarks

curator heel

for children means

"ordinary shoes"

Certain foot ailments and leg weaknesses can be put right without T-irons or surgical boots. Wherever possible doctors use a light-weight corrective heel, knowing the immense difference such an "ordinary look" makes to a child's attitude towards its own physical handicaps. Full details of *Clarks Curator Heel* are available to the medical profession, children's clinics, etc., on application to Clarks.

C. & J. CLARK LTD.
(*Shoemakers since 1825*) STREET, SOMERSET

All Text Volumes Now Published
Index Volume Ready Shortly

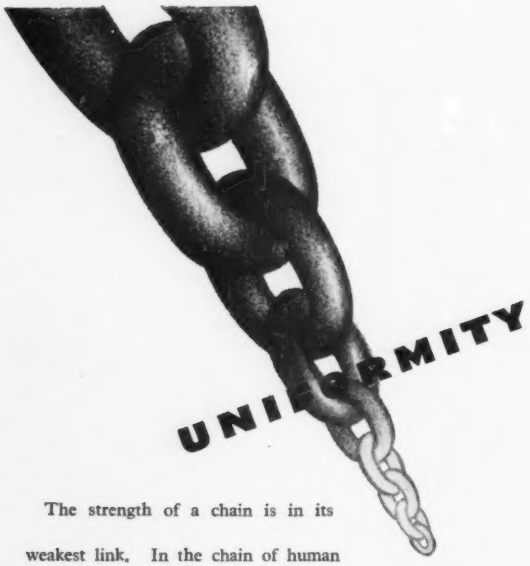
BRITISH SURGICAL PRACTICE

Under the General Editorship of
Sir Ernest Rock Carling, F.R.C.S., F.R.C.P.
Consulting Surgeon, Westminster Hospital
and
Sir James Paterson Ross, K.C.V.O., M.S., F.R.C.S.
Surgeon and Director of Surgical Clinical Unit, St Bartholomew's Hospital; Professor of Surgery, University of London

"It is clear, as the successive volumes emerge, that this work is achieving the very difficult and ambitious task which it set out to accomplish—to present an up-to-date and authoritative survey of British Surgery."—*The Lancet*

In Eight Volumes and Index
Price £3 per Volume. Index £1. Carriage and packing extra

BUTTERWORTH & CO. (Publishers) LTD.
Bell Yard, Temple Bar, London, W.C. 2.



The strength of a chain is in its weakest link. In the chain of human endeavour supporting the surgeon's skill, there can be no weakness . . . the catgut he uses must present no hazards for the knot to find. The surgeon's confidence demands uniformity of gauge throughout the suture length. Nowhere is surgical trust better placed than in the suture processed by modern scientific methods keyed specially to provide uniformity of gauge.

UNIFORMITY—THE SURGEON'S SECURITY AGAINST THE INQUISITIVE KNOT

ETHICON SUTURE LABORATORIES LIMITED, BANKHEAD AVENUE, EDINBURGH

THE C·M·C

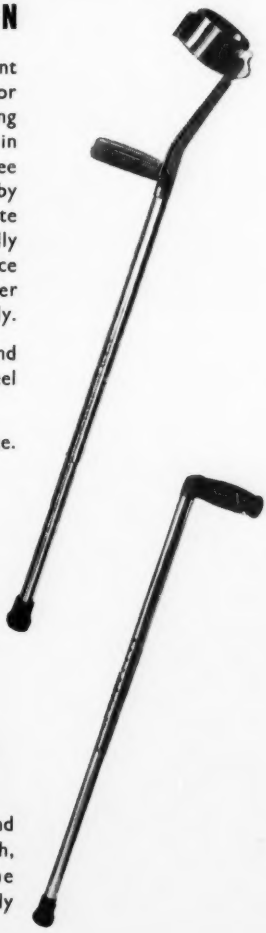
Telescopic
ADJUSTABLE
CRUTCH
AND WALKING STICK

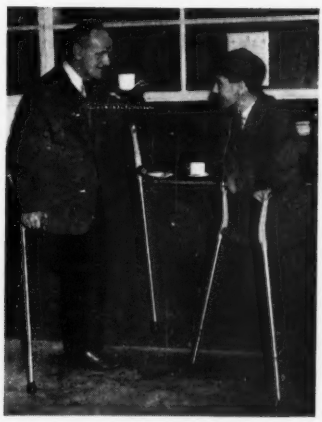
A TREMENDOUS ADVANCE IN CRUTCH DESIGN

Telescopic Tubes with spring-loaded plungers (having independent springs for complete safety) make Crutch adjustable in length for people of all heights. Hinged Forearm Rest supports arm, leaving hand free for opening doors, etc. This Forearm Rest will lock in horizontal position, enabling body to be completely relaxed. (See illustration on right.) Locking plunger automatically released by lifting Crutch. Exact fitting of the two tubes gives absolute rigidity and freedom from noise. Bottom of tube specially rounded to form cushion inside ferrule, ensuring non-slip surface and reducing wear inside rubber ferrule. Thick, soft, rubber grips give maximum comfort and minimum shock load to body.

Made of high tensile light alloy metal, polished, non-corrosive and vermin-proof. Forearm Clip made of heat-treated spring steel covered with celluloid to avoid damage to clothes or skin.

Light, compact and portable. Easily packed in small suitcase. Easily stored. Weight only 1 lb. 13 ozs.





Write for Literature

WALKING STICK

Similar in design and construction to Crutch, and embodying same principles. Weight only 1 lb. 5½ ozs.

Designed & Manufactured by

CONCENTRIC MANUFACTURING CO. LTD.
TYBURN ROAD · BIRMINGHAM 24
TELEPHONE EAST 2081/2/3/4/5

J. E. HANGER & CO. LTD.

Specialists in
the manufacture of
Artificial Limbs

Contractors to the Ministry of Pensions for artificial limbs for the War-disabled and also for civilian limbless under the National Health Service.

These two children, aged 5 years and 15 months respectively, have each suffered the loss of one of their legs but are now able to run around happily. The little boy is the youngest child that has ever been fitted with an artificial leg, being under 1 year old at the time.

Branches at all Ministry of Pensions Limb Fitting Centres in Great Britain

J. E. HANGER & COMPANY LIMITED
Queen Mary's (Roehampton) Hospital, Roehampton, London, S.W. 15. **Phone: PUTney 4422 (5 lines)**

A NEW PLASTER BOOT

(Patents pending)

The LUDUN Boot is the result of several years' research and this latest model permits an easy normal gait for those patients who have their legs in plaster.

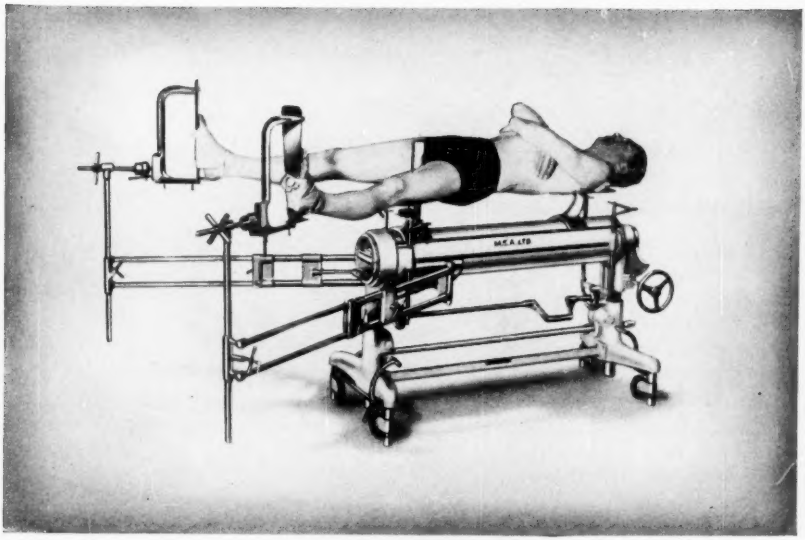
Features:

1. Smart looking footwear — easily removable and weatherproof.
2. Good quality leather allows repeated use by many patients.
3. Lined with sorbo pads and fitted with a spring steel strip to absorb shock.
4. Radius in design of sole gives normal heel-toe action.

LUDUN Ltd. is a non-profit-making Company formed to employ severely disabled people and help them through gainful occupation to restore confidence in themselves as useful citizens.

Address inquiries to:

LUDUN Ltd., 22 Lewsey Road, Luton, Bedfordshire, England



The NEW IMPROVED

"SHROPSHIRE" ORTHOPÆDIC HORSE

DESIGNED to give the greatest accessibility to the surgeon for the reduction of fractures, their control by X-rays, and for their immobilisation, the New Improved Shropshire Orthopædic Horse enables a greater variety of procedures to be carried out with much greater ease than is permitted by any other apparatus for a like purpose.

AN "Emesay" PRODUCTION

MANUFACTURED BY

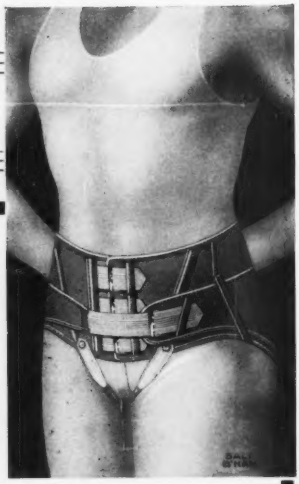
THE MEDICAL SUPPLY ASSOCIATION LTD.

167-173 GRAY'S INN ROAD, W.C. 1, and 95 WIMPOLE STREET, W. 1

PHONES: TERminus 5432 (Six lines) LONDON

EDINBURGH: 10-13 TEVIOT PLACE SHEFFIELD: 6-12 HOLLY STREET

A perfect Appliance for its purpose:



SALTS' SACRO-ILIAC BELT

Designed by an eminent orthopaedic specialist, this Belt is available in styles for ladies and gentlemen. Its perfect efficiency is accompanied with complete comfort. Rapidly restoring the normal relationship of the sacral and iliac bones, it also exerts a beneficial effect on the tone of the abdominal viscera. Not the least commendable thing about this Belt is the fact that it enables the patient to make early resumption of normal activities. Further details and Measure/Order forms available to medical people on request.

Appointments in London —
1 STANLEY HOUSE
105 Marylebone High St., London, W.1
WELBECK 3034

SALT & SON LTD.

5-6-7 CHERRY STREET, BIRMINGHAM, 2

Vokes Ernst limb for above knee amputation. One of the comprehensive range manufactured in light metal designed to meet every requirement.

The double swivel pelvic band is the finest system of suspension for the majority of above-knee amputations, permitting complete freedom of action with firm support and perfect control. The central mounting of the socket swivel ensures that the limb does not fall away from the stump when the full range of movement is used—a very valuable feature when playing such games as tennis or golf.

The construction of the Wheel Control Knee mechanism is simple and robust and will give many years of hard service. Note the high-duty compound ball-bearing knee-joint and the rubber return spring which is out of action when sitting.

The unique mechanism of the Vokes Ernst cushion joint movable ankle combines both the joint and the spring action of the foot in one single unit. It is the lightest yet produced and the whole movement takes place in the rubber torsion-joint itself, no adjustments or lubrication are necessary, and noise is impossible.

Frictionless bearing ankle mechanism of the rubber buffer type with self-oiling bearings, also available.

ARTIFICIAL LEGS

Artificial legs, manufactured and supplied by Vokes Ernst Scientific Surgical Appliances Ltd., are widely prescribed in private practice and are also approved by the Ministry of Pensions for supply under the National Health Scheme. Centres which have been, or are in course of being, opened in strategic points throughout Britain for fitting and servicing under qualified supervision include:

FITTING CENTRES:

LONDON	Queen Mary's Hospital, Roehampton Lane, S.W. 15
,,	73 Baker St., London, W. 1. Welbeck 3924
BIRMINGHAM	73 Stafford St., Birmingham, 4. Central 1940
MANCHESTER	39 Byrom Street, Manchester, 2
GLASGOW	Ministry of Pensions, War Pensions Welfare Service, 134 Sauchiehall St., Glasgow, C. 2
LEEDS	Chapel Allerton Hospital, Leeds
SWANSEA	27 Cradock St., Swansea
BRISTOL	Vassall Road, Fishponds, Bristol

VOKES ERNST SCIENTIFIC SURGICAL APPLIANCES LTD.

(A subsidiary Company of Vokes Ltd.)

Head Office: Henley Park, Guildford, Surrey
Telephone Guildford 62861

Factory: Alton, Hants. Telephone Alton 2294

.....but it won't cut *skin*

This new Desoutter electric power Tool was developed specially to make the removal of surgical plasters a fast and safe operation—safe for both patient and operator. The circular saw does not rotate, it oscillates through an arc only a few degrees wide at about 18,000 strokes per minute. This ultra rapid short stroke movement will not cut when it is in contact with mobile skin or soft material. But when up against hard materials like plaster it is an extremely efficient cutter. Please write for the leaflet which explains the method of use.

DESOUTTER BROS LTD THE HYDE · HENDON · LONDON · NW9

Tel: Colindale 6346 · 'Grams: Despnuco · Hyde · London

CRC1

Patent Pending

HIP ARTHROPLASTY
with
PROSTHETIC HEADS
●
TECHNIQUE
of
Doctors
R. and **J. JUDET**

Reinforced Monobloc
and Grooved
Drs JUDET'S MODEL
is made of

1. Stainless Steel Armature of high breaking strength embedded before polymerisation. (By this process no plugs or cement are used in inserting of the armature.)
2. Grooves preventing the risk of rotation.
3. Grooves specially ended to prevent risk of extraction.

Ossacryl
Registered Trade Mark

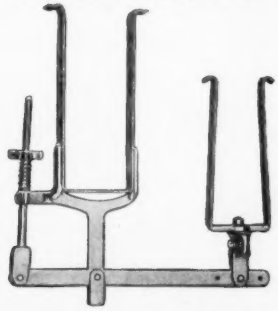
Explanatory leaflet P.67 giving full details on heads and instruments **on request.**

Manufactured by

DRAPIER *Surgical Instruments* **41 Rue de Rivoli, PARIS (1°)**

Problems? HERE ARE SOME ANSWERS!

Comminuted intertrochanteric fractures, especially in senile patients?



No. 300—Well-Leg Splint, $35.00

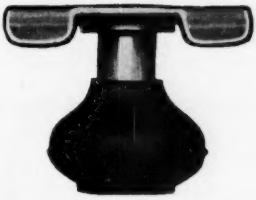
This original and standard Roger Anderson well-leg splint supplies abduction, internal rotation, and fixation. Convalescence is favorable since patient is up in the wheel chair.

Where can I buy finger traps?

No. 504—Finger Traps, $2.25 each

Specify small, medium or large. These are *silver-plated* to permit sterilization without rusting.

How to prevent torsional strain on walking leg casts?
How to keep leg-boot looking trim?



No. 755—Swivel Walking Button, $2.75 each
$2.50 each in lots of 12
Rubber tip replacements, $0.50

Exclusive ball and socket construction. Gives almost normal heel and toe movement in walking on any level. No metal straps to impair X-ray examination of ankle.

How to reduce certain wrist fractures?
How to support arm for cast application?

No. 505—Self-Equalizing Finger Traction Assembly, now only $19.50 complete

Includes pulley assembly and traction plate, sturdy counter-traction strap with buckle, and 3 silver-plated finger traps. Maintains accurate and equal traction on one, two, or three fingers at once.

Are cast knives all alike?

No. 718—$6.00 complete

Here's one that's different. Slip-proof handle even when it's wet. Sharp steel blade easily adjusted to your requirement. Replaceable blade may be sharpened many times since extra cutting length is available.

Order from your favorite dealer or direct

the TOWER COMPANY, Inc.

SEATTLE, WASHINGTON
P. O. BOX 3181

GENEVA, ILLINOIS
(Near Chicago)

Journal of Bone and Joint Surgery

BINDING YOUR JOURNAL

Arrangements have been made to supply official binding cases to bind your Journal at the following charges:

BINDING, including case 15/- net postage 1/2

CASES only, 2/6 net postage 3d.

★

Apply to the Publishers

E. & S. LIVINGSTONE LTD.
16 and 17 TEVIOT PLACE
EDINBURGH, SCOTLAND

ORTHOPÆDIC APPLIANCES

Makers to the
LONDON HOSPITAL
since 1860

EXPERIENCED FITTERS ARE AVAILABLE IN MANY COUNTIES

ALFRED COX (SURGICAL) LTD
Incorporating
KROHNE & SESEMANN
108 WHITECHAPEL ROAD
LONDON, E.1
Telephone: BISHOPSGATE 3804

EXCERPTA MEDICA
The International Medical Abstract Service published in English and covering the whole field of Clinical and Experimental Medicine.

SURGERY *SECTION IX*

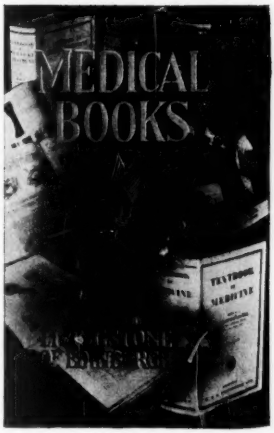
CONTENTS. In this Section the whole field of Surgery is covered and includes general surgery, urological surgery, orthopaedic surgery, thoracic surgery, plastic surgery, casualty (or traumatic) surgery, surgery of the thyroid gland and surgery of children.
Selected abstracts of articles on neurological and oral surgery also appear in this section.
Abstracts of articles on pre- and post-operative care and surgical nursing are published.

The Journal of Bone and Joint Surgery, Boston:
". . . The abstracts are very well done, and we should be most grateful to our Dutch friends for this important contribution."

The subscription rate is £6. 4s. per yearly volume of 1920 pages, including an index classified both by author and subject. Write for a prospectus or specimen copy.
Sole Distributors for Great Britain and the British Dominions:
E. & S. LIVINGSTONE, LTD., 16-17, TEVIOT PLACE, EDINBURGH, 1

". . . To study the phenomena of disease without books is to sail an uncharted sea."

WM. OSLER
"Books and Men."



"In science, read by preference the newest books; in literature, the oldest."

CAXTONIA
"Hints on Mental Culture."

★ *SOME NOTABLE PUBLICATIONS* ★

THE CLOSED TREATMENT OF COMMON FRACTURES

By JOHN CHARNLEY, B.Sc., M.B., F.R.C.S. Foreword by Sir HARRY PLATT. 200 pp. 133 illustrations. **35s.**

"There are other and larger books written about the treatment of fractures but none so vital as this. There is not one of the 190 pages; there is hardly a sentence; and there is not an illustration which the reader will not want to underline because of its importance, and it is suggested that these remarks apply not only to resident casualty surgeons. It is believed that every orthopaedic and traumatic surgeon in Great Britain and elsewhere will agree that this book has something to teach him."—*British Journal of Surgery.*

JOHN HUNTER

By S. ROODHOUSE GLOYNE, M.D. 112 pp. 12 plates. **15s.**

An excellent monograph which tells the story of John Hunter in the setting of his period.

LORD LISTER: HIS LIFE AND DOCTRINE

By DOUGLAS GUTHRIE, M.D., F.R.C.S. (Edin.). 136 pp. 20 plates. **15s.**

"This book is written in a stimulating and lucid style, and gives the reader a very good mental picture of Lister's life and doctrine. It will appeal both to the undergraduate and graduate."—*British Journal of Surgery.*

INJURIES OF THE KNEE JOINT

Second edition. By I. S. Smillie, O.B.E., Ch.M., F.R.C.S. 402 pp. 451 illustrations. **50s.**

"A book which will be valuable to those with sufficient experience to enable them to peruse its pages with discernment."—*British Journal of Surgery.*

CLEFT PALATE AND SPEECH

Second edition. By MURIEL MORLEY, B.Sc., F.C.S.T. 172 pp. Fully illustrated. **12s. 6d.**

"A book that is particularly valuable in that it cements the association between surgeon and speech therapist."—Extract from Foreword by Richard Battle, M.Chir., F.R.C.S.

NON-GONOCOCCAL URETHRITIS

By A. H. HARKNESS, M.R.C.S., L.R.C.P. 436 pp. 167 illustrations. **52s. 6d.**

"From time to time it is our pleasure to review in these columns a book on some special subject which is of such merit as to constitute a landmark in our knowledge of disease and to evoke a feeling of pride that it has been written in the English language. It is certain that Harkness on non-gonococcal urethritis is worthy of a place in this select category.

"The author's own expert opinion permeates the text and gives it the touch of greatness: we congratulate him on producing a superlative monograph and a surgical classic."—*British Journal of Surgery.*

★ *Please write for a copy of the complete illustrated catalogue* ★

E. & S. LIVINGSTONE LTD., TEVIOT PLACE, EDINBURGH

Colour Portraits

A few specially mounted prints of the colour portraits of LISTER, JOHN HUNTER, HUGH OWEN THOMAS, ROBERT JONES, Dame AGNES HUNT, WILLIAM JOHN LITTLE and PERCIVAL POTT are still available.

Price **10/6** *each, including postage*

Unmounted Prints of the above are also available with the addition of the latest colour prints of ABRAHAM COLLES and FRANCIS GLISSON.

Price **3/6** *each*

E. & S. LIVINGSTONE LTD., EDINBURGH

ADVERTISERS—NOVEMBER 1950

	Page
Austenal Laboratories Inc.	xi
Brooks Appliance Co. Ltd.	xv
Butterworth & Co. (Publishers) Ltd.	xvii
S. H. Camp & Company Ltd	vii
C. & J. Clark Ltd.	xvii
Concentric Manufacturing Co. Ltd.	xix
Alfred Cox (Surgical) Ltd.	xxvi
Desoutter Bros. Ltd.	xxiii
Down Bros. and Mayer & Phelps Ltd.	xiv
Drapier Surgical Instruments	xxiv
Ethicon Suture Laboratories Limited	xviii
Excerpta Medica	xxvi
J. E. Hanger & Co. Ltd.	xx
Ilford Limited	xvi
E. & S. Livingstone Ltd.	xxvii
Lloyds Bank Limited	xvii
London Splint Company Limited	viii
Ludun Ltd.	xx
Medical Supply Association Ltd.	xxi
Paragon Razor Company	xiii
Salt & Son Ltd.	xxii
T. J. Smith & Nephew Ltd.	x
Spencer (Banbury) Ltd	ix
Chas. F. Thackray Ltd.	xii
The Tower Company Inc.	xxv
Vokes Ernst Scientific Surgical Appliances Ltd.	xxii
Westminster Bank Limited	xv

ACKNOWLEDGMENTS

We acknowledge with thanks receipt of:

Acta Chirurgica Scandinavica, and Supplements
Acta Orthopaedica Belgica
Annals of the Royal College of Surgeons of England
Archives of Surgery
Australian and New Zealand Journal of Surgery
British Journal of Surgery
British Medical Bulletin
Cirugia del Aparato Locomotor
Chirurgia et Orthopaedia—Sofia
Journal of Neurology, Neurosurgery and Psychiatry
Journal of the American Medical Association
Lancet
Medical Journal of Australia
New England Journal of Medicine
Ortopedia e Traumatologia
Radiology
Revue d'Orthopédie
South African Journal of Medical Sciences
Surgery, Gynecology and Obstetrics
Zeitschrift für Orthopädie und ihre Grenzgebiete

CONTRIBUTORS—NOVEMBER 1950

Dr LEROY ABBOTT, M.D., 384 Post Street, San Francisco 8, California, United States of America.
Dr THOMAS B. ACKER, M.D., 301 Barrington Street, Halifax, Nova Scotia, Canada.
J. CRAWFORD ADAMS, Esq., M.D., F.R.C.S., St Mary's Hospital, London, England.
Dr RUFUS H. ALLDREDGE, M.D., 1538 Louisiana Avenue, New Orleans, Louisiana, United States of America.
Dr CARL BADGLEY, M.D., 1313 E. Ann Street, Ann Arbor, Michigan, United States of America.
ROLAND BARNES, Esq., F.R.C.S., Orthopaedic Department, Western Infirmary, Glasgow, Scotland.
Dr JOSEPH BARR, M.D., 234 Marlborough Street, Boston 16, Massachusetts, United States of America.
Dr WALTER BLOUNT, M.D., 324 E. Wisconsin Avenue, Milwaukee 2, Wisconsin, United States of America.
Dr AARON BODANSKY, M.D., Hospital for Joint Diseases, 1919 Madison Avenue, New York, United States of America.
J. G. BONNIN, Esq., F.R.C.S., Central Middlesex Hospital, Park Royal, London, N.W. 10, England.
Dr JOSEPH BOYES, M.D., 1401 South Hope Street, Los Angeles 15, California, United States of America.
D. M. BROOKS, Esq., F.R.C.S.I., Institute of Orthopaedics, Royal National Orthopaedic Hospital, 234 Great Portland Street, London, W. 1, England.
H. JACKSON BURROWS, Esq., M.D., F.R.C.S., F.R.A.C.S., 25 Upper Wimpole Street, London, W. 1, England.
ST. J. D. BUXTON, Esq., F.R.C.S., 16 Roehampton Gate, London, S.W. 15, England.
Miss DOROTHY DUCAS, Public Relations Director, National Foundation for Infantile Paralysis, 120 Broadway, New York, United States of America.
J. M. EDELSTEIN, Esq., F.R.C.S.E., 170 Lister Building, Jeppe Street, Johannesburg, South Africa.
Dr W. E. GALLIE, M.D., 607 Medical Arts Building, Toronto, Ontario, Canada.
ALEXANDER GIBSON, Esq., F.R.C.S., 601 Medical Arts Building, Winnipeg, Manitoba, Canada.
WILLIAM GISSANE, Esq., F.R.C.S., Birmingham Accident Hospital, Bath Row, Birmingham, 15, England.
D. LL. GRIFFITHS, Esq., F.R.C.S., Manchester Royal Infirmary, Manchester, England.
Dr R. I. HARRIS, M.D., 609 Medical Arts Building, Toronto, Ontario, Canada.
Dr VERNE T. INMAN, M.D., University of California Medical Center, San Francisco, California, United States of America.
Dr HENRY L. JAFFE, M.D., Hospital for Joint Diseases, 1919 Madison Avenue, New York, United States of America.
THOMAS KING, Esq., M.D., F.R.C.S., Alcaston House, 2 Collins Street, Melbourne, C. 1, Australia.
Major-General NORMAN T. KIRK, Surgeon General's Office, War Department, Washington 25, D.C., United States of America.
B. L. MCFARLAND, Esq., M.D., M.Ch.Orth., F.R.C.S., 41 Rodney Street, Liverpool 1, England.
Dr ANGUS MCLACHLIN, M.D., Victoria Hospital, London, Ontario, Canada.
Dr PAUL MAGNUSON, M.D., 700 N. Michigan Avenue, Chicago 11, Illinois, United States of America.
Dr LEO MAYER, M.D., 1150 Fifth Avenue, New York 28, N.Y., United States of America.
Dr FRANK H. H. MEWBURN, M.D., 10136 100th Street, Edmonton, Alberta, Canada.
Dr HENRY MILCH, M.D., 225 W. 86th Street, New York 24, N.Y., United States of America.
COATES MILSOM, Esq., M.B., M.Ch.Orth., Mountain Road, Auckland, New Zealand.
Dr JESSE T. NICHOLSON, M.D., 330 S. Ninth Street, Philadelphia 3, Pennsylvania, United States of America.
E. A. NICOLL, Esq., M.A., M.D., F.R.C.S.E., 21 Woodhouse Road, Mansfield, Nottinghamshire, England.
Dr J. A. NUTTER, M.D., 48 Chesterfield Avenue, Westmount, Montreal, Quebec, Canada.
H. OSMOND-CLARKE, Esq., C.B.E., F.R.C.S., 80 Harley Street, London, W. 1, England.
Med. Dr IVAR PALMER, Överläkare, Docent i kirurgi, Södersjukhuset, Stockholm, Sweden.
Dr J. P. PATTERSON, M.D., 614–619 Birks Building, Vancouver, B.C., Canada.
Professor GEORGE PERKINS, M.C., F.R.C.S., Department of Surgery, St Thomas's Hospital Medical School, London, S.E. 1, England.
Dr WINTHROP PHELPS, M.D., 3038 St Paul Street, Baltimore 18, Maryland, United States of America.
Sir HARRY PLATT, M.D., M.S., F.R.C.S., F.A.C.S., 11 Lorne Street, Manchester 13, England.
E. W. RICHES, Esq., M.C., F.R.C.S., 22 Weymouth Street, Portland Place, London, W. 1, England.
J. H. G. ROBERTSON, Esq., M.Ch.Orth., F.R.C.S. (Ed.), Memorial Hospital, Bulawayo, Southern Rhodesia.
Dr WILLIAM A. ROGERS, M.D., 266 Beacon Street, Boston 16, Massachusetts, United States of America.
Dr HOWARD RUSK, M.D., New York Times, Times Building, 42nd Street, New York, United States of America.
Dr FREDERICK VOM SAAL, M.D., 140 East 54th Street, New York 22, N.Y., United States of America.
Dr EDWARD B. SCHLESINGER, M.D., 710 West 168th Street, New York, United States of America.
Dr A. R. SHANDS, Jr., M.D., Rockland Road, Wilmington, Delaware, United States of America.
Dr S. LEONARD SIMPSON, M.B., B.Ch., 77 Harley Street, London, W. 1, England.
Dr H. A. SISSONS, M.B., B.S., Department of Pathology, Royal National Orthopaedic Hospital, 234 Great Portland Street, London, W. 1, England.
Dr HUGH SMITH, M.D., 869 Madison Avenue, Memphis 3, Tennessee, United States of America.
T. T. STAMM, Esq., F.R.C.S., Guy's Hospital, London, S.E. 1, England.
Dr OTTO STEINBROCKER, M.D., 121 East 60th Street, New York, United States of America.
Dr CHARLES SUTRO, M.D., 755 Park Avenue, New York 21, N.Y., United States of America.
DAVID TREVOR, Esq., M.S., F.R.C.S., Institute of Orthopaedics, Royal National Orthopaedic Hospital, 234 Great Portland Street, London, W. 1, England.
O. J. VAUGHAN-JACKSON, Esq., B.M., B.Ch., F.R.C.S., The London Hospital, London, E. 1, England.
A. D. LE VAY, Esq., M.S., F.R.C.S., 35 Alleyn Park, London, S.E. 21, England.
Dr ALLEN VOSHELL, M.D., 101 W. Read Street, Baltimore 1, Maryland, United States of America.
Sir REGINALD WATSON-JONES, B.Sc., M.Ch.Orth., F.R.C.S., 82 Portland Place, London, W. 1, England.
Dr SAMUEL WISHIK, M.D., Department of Health, 420 23rd Street, New York, United States of America.

PRINTED IN GREAT BRITAIN BY PILLANS & WILSON LIMITED, EDINBURGH

THIS PUBLICATION IS REPRODUCED BY AGREEMENT WITH THE COPYRIGHT OWNER. EXTENSIVE DUPLICATION OR RESALE WITHOUT PERMISSION IS PROHIBITED.